CLASSIFICATION OF EXHIBITS.

Chief Barrett has issued the following notice: — By special arrangement with the Director-General, this department has the privilege to add to the classification originally adopted by the World's Columbian Commission, and it has been determined that this addition shall take the form of a new group. Classes have been added under this group sufficient to cover a variety of apparatus either properly electrical, or auxiliary to other exhibits essentially electrical in character. A number of our exhibitors have found difficulty in properly classifying some of their apparatus, and it is hoped that this new group has been made general enough to cover everything not heretofore classified. Those exhibitors who have found difficulty in properly classifying their exhibits will confer a favor on the department by sending to us immediately a list of those things in their exhibits which can be better classified under this new group than in the old classification. Early attention to this matter will make it possible for the department to give proper credit to exhibitors in the first edition of the official catalogue.

GROUP 138 "A."

Class *a* — Construction tools, repairing tools, apparatus used in electrical construction.

Class *b* — Apparatus for transmission of power to electrical generators. (Steam, compressed air, turbine, oil, friction, gearing, belting, etc., etc.)

Class *c* — Processes of electro-engraving.

Class *d* — Carbon and its application.

Class *g* — Metals and their application in the construction of electrical apparatus.

Class *h* — The "Kinetograph."

Class *j* — Direct couple engine dynamos.

Class *k* — Electric lubricators.

Class *l* — Application of electricity in testing and ageing liquors.

Class *m* — Electric tanning.

RULES GOVERNING THE SUPPLY OF LIGHTING AND POWER TO EXHIBITORS IN THE DEPARTMENT OF ELECTRICITY.

Exhibitors in the Electricity building will be divided into two classes: First, those who contribute to the service of lighting and electric power transmission for the building; second, those who do not so contribute.

Contributors will be again divided into two classes:

(1) Those who furnish generators connected to prime movers in Machinery hall.

(2) Those who contribute to the service lighting of Electricity building through motor power taken from circuits in the Electricity building.

Contributors to either class will be required to enter into formal contract for furnishing and operating machinery offered, in accordance with the following general terms:

No steam power being available in the Electricity building, all generators provided by contributors of class (1) must be installed in Machinery hall.

Generators provided by American companies will be located in the regular service plant in Machinery hall. Generators provided by foreign companies will be located in the spaces severally allotted to these countries in Machinery hall.

Power circuits will be led from the generators of each contributor of class (1) through existing subways from Machinery hall to the Electricity building. The several exhibitors offering generators for this service are expected to furnish and install, at their own expense, subject to the supervision of the World's Columbian Exposition, the several power circuits before mentioned.

The aisles of the Electricity building will be illuminated by arc lights, which will be considered the service lighting for the building. Arc lights in addition to these, as well as all incandescent lights and power for keeping exhibits in motion, will be considered as special service rendered to individual exhibitors.

Power for operating generators needed for the service lighting will be furnished free of cost to the exhibitors installing this

light. In consideration of such contribution to the service lighting of Electricity building, exhibitors participating in this service will be granted such amount of extra power and light for the operation of their own exhibits as may be mutually agreed upon in contract.

Arc and incandescent lights may be taken direct from the several power circuits leading from Machinery hall, or they may be furnished from generators driven by motors taking current from the power circuits before mentioned, motors and generators in this latter case being located in the Electricity building. Arc lights for all-night service are an exception to this rule, and will be supplied from the regular service plant already contracted for by the World's Columbian Exposition.

Contributors of class (2) who use current from the power circuits will be expected to provide the necessary motors, generators and shafting free of cost to the World's Columbian Exposition. Exhibitors contributing to the arc lighting necessary in the service of the building will be expected to wire, hang, and maintain such lamps as may be assigned to them, free of cost to the World's Columbian Exposition. Such arc lamps, incandescent lights and motors as may be installed within the contributing exhibitor's space will be wired and hung by said exhibitor at his own expense.

In order to provide for lighting and power service to those exhibitors who do not contribute to the service of Electricity building, it is proposed to assign to each exhibitor contributing to said service, a specified portion of the Electricity building in which to furnish special lighting and power. All work of wiring, hanging, and maintenance of lamps, etc., done for other exhibitors in such space, will be paid for by the Exposition Company at the following rates:

(1) For each incandescent lamp, including the first lamp and socket with installation on a plain cord or pendant, $3.50 per 16 candle-power lamp.

(*a*) Special fancy wiring will be furnished at an extra cost, to be paid by consumer, under special agreement.

(*b*) Fixtures and shades will be furnished and maintained by consumer.

(*c*) Lamps of other capacities, fancy or colored lamps, will be furnished in accordance with special agreement. Lamp renewals

must be furnished free of charge by contributor. Breakages must be purchased by consumer from the exhibitor supplying his exhibit, at the usual market price.

(2) For each arc lamp, including ceiling block, suspension rod, and lamp complete, $35. Lamps must be furnished with opal globes. All care and attendance to lamps and circuits must be furnished without extra charge by the contributor maintaining the circuit.

(3) All wiring necessary for the installation of motors within the space assigned to each contributor, shall be done by said contributor, at the expense of exhibitor desiring said power.

Service connections, as well as all lamps and sockets installed at contributor's expense, shall be maintained and owned by said contributor. All alterations of original installation shall be made by said contributor, after written agreement with the exhibitor desiring change.

All installation and operation shall be subject to the inspection and approval of the Chief of the Department of Electricity. Installation must conform to the National Code of the Board of Underwriters, subject to the inspection and approval of the Director of Works of the Exposition.

ADDITIONAL ILLUMINATION.

The aisles of the building will be illuminated with arc lamps without cost to exhibitors; additional lighting to be paid for by exhibitors at the following rates:

Arc lamps, service May 1, 1893, to October 30, 1893, inclusive, during Exposition hours, $65 per lamp of 2,000 nominal candle-power; lamps suspended from ceiling, with opal globes and globe nets, special fixtures or globes, or special ornamental lamps, will be subject to an extra charge.

Incandescent lamps, service May 1, 1893, to October 30, 1893, inclusive, during the hours of the Exposition, $8 per 16 candle-power lamp, including installation of first lamp and socket and lamp renewals; breakages must be purchased by exhibitor of the contractor lighting his space, at the usual commercial rate. Lamps will be hung on plain cords or pendant; special or fancy wiring will be furnished at an extra charge. Fixtures and shades will be furnished and maintained by consumer. Special colored or fancy lamps, or lamps of other than 16 candle-power, will be subject to

special agreement. Installations of 500 lamps or more will be subject to special discount.

MOTORS.

Electric power only will be supplied in the Electrical building.

Exhibitors requiring motive power will furnish necessary motors, rheostats, main line switches, insulating base, etc., complete, together with all belts, countershafting, and other means of connecting motors to operating machinery. Motors should be suitable for operation on class of circuit furnished in exhibitor's location.

The rheostats must be constructed wholly of non-combustible material. The main line switch shall be of the "knife-blade" type, of ample carrying capacity, and suitable for breaking current at the potential used. Motors shall be erected in position at the expense of the exhibitor by the contractor furnishing power in the location of his exhibit; service connections being installed, maintained and owned by the said contractor.

Charges for service connections with the main line will be as follows:

For ½ h.-p. and less	$8.00
For 1 h.-p. to 5 h.-p.	12.00 per h.-p.
For more than 5 h.-p. not exceeding 10 h.-p.	10.00 per h.-p.
For more than 10 h.-p.	8.00 per h.-p.

Fractions of a horse-power will not be considered, except for motors of less than one horse-power.

Ratings of motors will be the standard rating of the manufacturer.

Charges for service will be based on the maximum electrical horse-power delivered to the motor, irrespective of the class of work to be operated by the motor, at the following rates:

For ¼ h.-p. and less	$15.00
For more than ¼ h.-p., and not exceeding ½ h.-p.	30.00
For more than ½ h.-p., and not exceeding 1 h.-p.	50.00
For more than 1 h.-p., and not exceeding 2 h.-p.	45.00 per h.-p.
For more than 2 h.-p., and not exceeding 3 h.-p.	42.50 per h.-p.
For more than 3 h.-p.	40.00 per h.-p.

A limited amount of power may be furnished to exhibitors free of charge, to simply turn over an otherwise inoperative exhibit.

RULES AND REGULATIONS FOR THE SUPPLY OF ELECTRICITY, STEAM, COMPRESSED AIR AND POWER FROM SHAFTING.

GENERAL CONDITIONS.

(1) The Director-General has general charge of the installation of all exhibits, and the control and management of the same to the closing of the work of the Exposition, through the Department Chiefs, under the system heretofore established and now recognized by law as existing agencies. The Director-General has exclusively to do with all exhibitors in their connection with or relation to the Exposition, it being understood that so much of the regular power and light plant accepted as exhibits shall be under the control of the Director of Works.

(2) Exhibitors desiring to contract for service of electricity, steam, compressed air, power from shafting, gas, or water, must make application to the Chief of the Department in which their exhibits are installed. No application will be entertained unless made upon a blank furnished by the Chief of Department; and when an application has been approved by the Director-General, a contract will be executed on the part of the World's Columbian Exposition by the Director of Works, provided it is not impracticable, on the terms and conditions hereinafter specified.

In no case will service be furnished except under authority of contract in writing, the payments for which shall be made by the applicant to the World's Columbian Exposition at the time of the execution of said contract.

(3) Service will be provided from May 1 to October 30, 1893, inclusive.

(4) The Exposition management will not be responsible for stoppages from any reasonable cause.

(5) A limited amount of power will be supplied gratuitously to turn over, periodically, an otherwise inoperative exhibit; the length of time such exhibit shall be operated to be determined by the Chief of Department.

(6) The authorized representative of the management of the World's Columbian Exposition shall have access to the consumer's space for the purpose of inspection at all reasonable hours.

INCANDESCENT LIGHTING.

(1) The generators, primary system of wiring, and converters will be installed, operated and maintained by the World's Columbian Exposition.

(2) Service will be furnished from 100-volt alternating current system, as manufactured by the Westinghouse Electric & Manufacturing Company.

(3) All lamps, sockets, switches, cut-outs and other appliances must be adapted to the above named system.

(4) All power service for generating light will be furnished during the Exposition hours by the World's Columbian Exposition, from May 1 to October 30, 1893, inclusive, at the rate of $8 per 16 candle-power, lamp capacity, or the equivalent in lamps of other candle-power.

(5) National, state, territorial and foreign World's Fair boards and concessionaires must install, operate and maintain the wiring system for lighting their respective buildings at their own expense. The installation shall comprise all conductors and appliances necessary, from the converter to the lamps, and the first installation of lamps. The plans for such installation must be submitted for the approval of the Director of Works before installation commences, and the work shall be installed so as to meet with the approval of the Director of Works before connection can be made with the main circuits. The actual work of connecting the converter with the secondary system will, in all cases, be done without extra expense by the World's Columbian Exposition.

(6) Exhibitors occupying space in buildings owned by the World's Columbian Exposition must have their wiring installed by the World's Columbian Exposition, through its authorized contractors. All wiring and appliances installed by the World's Columbian Exposition will be, and remain, the property of the World's Columbian Exposition. The class of wiring installed will be that known as plain molding, or interior conduit work, and will include the first installation of lamps, plain key or keyless sockets, switches, cut-outs, and the hanging of the lamps on

plain cords or pendants, and shall be charged for at the rate of $3.50 per lamp. Special or fancy wiring will be furnished at an additional charge covering the actual cost to the World's Columbian Exposition. All fixtures and shades must be furnished by the consumer. Changes in location of lamps and appliances, when once installed, shall be subject to an additional charge.

(7) The lamps referred to herein, unless otherwise stipulated, are 16 candle-power plain lamps. Lamps of other capacities and fancy lamps will be subject to special agreement. Lamps of standard capacities for renewal purposes will be furnished to replace burned out lamps free of cost to consumer. Lamps accidentally broken or lost will be replaced at the expense of the consumer at the regular market rates. Special and fancy lamps must be renewed by the consumer.

POWER SERVICE.

(1) The generators and main conductors will be supplied, operated and maintained by the World's Columbian Exposition. The service conductors will be furnished at the consumer's expense, and at the rates hereinafter mentioned. The motors and appurtenances must be supplied, operated and maintained by and at the expense of the consumer. The service connections to the motors shall be installed, maintained and owned by the World's Columbian Exposition.

(2) The motor shall be suitable to operate on a 500-volt constant potential circuit. The rheostat shall be constructed wholly of non-combustible material. The main-line switch shall be of the "knife-blade" type, and suitable for working on a 500-volt constant potential circuit.

(3) No service will be rendered for less than $20. Fractions of horse-power will not be considered, except for motors of less than one horse-power. Charges will be made for service connections with the main line at the following rates:

For ½ h.-p. and less	$10.00
For 1 to 5 h.-p	15.00 per h.-p.
For more than 5 h.-p., not exceeding 10 h.-p	12.00 per h.-p.
For more than 10 h.-p	10.00 per h.-p.

(4) Charges for service will be based on the maximum electrical horse-power delivered to the motor, irrespective of the class of work to be operated by the motor, at the following rates:

For ¼ h.-p. and less.....$20.00
For more than ¼ h.-p., not exceeding ½ h.-p..... 40.00
For more than ½ h.-p., not exceeding 1 h.-p..... 75.00
For more than 1 h.-p., not exceeding 2 h.-p..... 70.00 per h.-p.
For more than 2 h.-p., not exceeding 3 h.-p..... 60.00 per h.-p.
For more than 3 h.-p..... 60.00 per h.-p.

(5) Special service for motors, not exceeding two horse-power, can be furnished from the regular alternating incandescent circuit.

(6) The above rates contemplate continuous service, or service on demand, at any time during the hours of the Exposition, from May 1 to October 30, 1893, inclusive. Consumers requiring power service for a specified number of hours only, will be charged at the rate of 5 cents per electrical horse-power hour; the specified time of day in which this service can be rendered to be determined each day by the Chief of the Department.

ARC LIGHTING.

(1) The main aisles of the Exposition buildings will be illuminated by arc lights free of expense to the exhibitor. A very limited number of arc lights will be supplied for private lighting on the following basis :

(*a*) The consumer shall pay the cost of wiring.

(*b*) The consumer shall pay for service, from May 1 to October 30, 1893, inclusive, at the rate of $60 per lamp of 2,000 (nominal) candle-power.

(*c*) Lamps will be suspended from the ceiling and furnished with opal globes. If any special fixture is required, it shall be furnished by the consumer.

(2) All care and maintenance of the lamps and circuits will be furnished by the World's Columbian Exposition without extra charge.

CHARGING STORAGE BATTERIES.

(1) The consumer shall provide lines and all material necessary from the main lines from which the current is to be distributed to storage batteries.

(2) Consumer shall provide all necessary labor and attendance connected with the charging or handling of the batteries.

(3) Current will be provided at the rate of 5 cents per electrical horse-power hour.

FOR MISCELLANEOUS PURPOSES.

(1) Electricity for special purposes will be subject to special agreement, to be determined at the time of making application therefor. Rates will be based either on those for power or those for charging storage batteries, according to the class of work to be performed.

STEAM FOR ALL PURPOSES.

(1) Piping and all connections from main lines shall be supplied, erected and covered with non-conducting material by the consumer.

(2) Plans for the arrangement of piping shall be submitted by the consumer for approval before work is begun.

(3) A rate of $40 per horse-power will be charged for steam supplied during the hours of the Exposition, from May 1 to October 30, 1893, inclusive. The above rate contemplates continuous service, or service on demand at any time during the hours of the Exposition. Consumer requiring power service for a specified number of hours only, will be charged at the rate of 4 cents per horse-power hour; the specified time of day in which this service can be rendered to be determined each day by the Chief of Department.

(4) The maximum rate of delivery to consumer's pipes shall form the basis of payment, irrespective of the class of work to be performed.

(5) The working pressure at the boilers will be 125 pounds per square inch.

COMPRESSED AIR FOR ALL PURPOSES.

(1) Piping and all connections from the main lines shall be supplied and erected by the consumer.

(2) Plans for the arrangement of piping shall be submitted by the consumer for approval before work is begun.

(3) Charges will be based on the equivalent in mechanical horse-power for the maximum rate of supply delivered to the consumer's pipe, at a rate of $60 per horse-power, during the hours of the Exposition, from May 1 to October 30, 1893, inclusive.

(4) The above rates contemplate continuous service, or service on demand at any time during the hours of the Exposition. Consumers requiring this class of power service for a specified number of hours only, will be charged at the rate of 5 cents per

horse-power hour; the specified time of day in which this service can be rendered to be determined each day by the Chief of the Department.

POWER FROM SHAFTING.

(1) The consumer shall supply and erect the pulley on the main line, together with all belts and connections, to operate his machinery; and all pulleys for the main shafts must be balanced, and must be made in halves, and so secured to the shafting as not to weaken or injure the same.

(2) A charge of $60 per horse-power will be made, based on the maximum rate of power supplied during the hours of the Exposition, from May 1 to October 30, 1893, inclusive. The above rate contemplates continuous service, or service on demand at any time during the hours of the Exposition. Consumers requiring power service for a specified number of hours only, will be charged at the rate of 5 cents per horse-power hour, the specified time of day in which this service can be rendered to be determined each day by the Chief of the Department.

(3) The diameter and revolutions of shafts, and maximum permissible diameter of driving pulley, will be given to the consumer at the time of the execution of the contract providing for power.

No steam or water pipes will be allowed to cross over passageways, except as specially provided for in Group 69, Class 417.

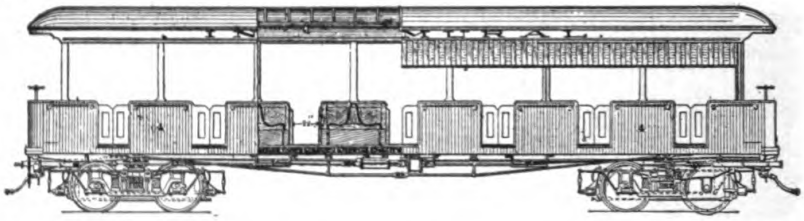
Water pressure will be that due to a head of 200 feet, or a pressure of 86 pounds per square inch.

Exhibitors furnishing machinery for the use of the Exposition may select their own men to operate them when necessary, subject to the approval of the Director of Works; their wages to be fixed by the Director of Works, subject to the approval of the Council of Administration.

THE INTRAMURAL RAILWAY.

While the electric launches will convey the visitor about the central portion of the grounds, the elevated electric railway will afford convenient rapid transit facilities to most of the other important points, including the Alley "L" Road, the Barre Sliding Railway and the main passenger depot.

The length of the line is about 3½ miles, and the 18 trains will be operated on a headway of 1½ minutes, or 40 trains an hour. The cars are of the summer open car type, 50 feet in length, 8 feet wide, and built to accommodate 100 passengers, 50 of whom can rest on hardwood seats extending the width of the car. Sliding side doors, controlled by a single lever, are used to inclose the entrances while the train is in motion, and heavy curtains will afford fair protection from the sunshine and rainstorms.



The loops, which are already built, will be at the south of the Convent La Rabida and over the lagoon north of the Fisheries building. The platform at the latter loop will extend to both sides of the lagoon. Leaving that point stops will be made at the Iowa State building, Fifty-seventh, Fifty-ninth and Sixty-second street entrances, Transportation building (Alley "L" terminal), Exposition railway terminal, at the Forestry building, and at the Colonnade. The stations will be covered platforms, with stairways leading to the tracks above. Tickets will be collected at the stairways, the same as on ordinary elevated roads. The fare is 10 cents, and 25 per cent of the gross receipts goes to the Exposition. The trains will consist of a motor car and three trailers, the former equipped with four T. H. 50 horse-power single reduction motors, and the current secured by an under-running trolley wheel.

A power house, enveloped in staff, has been erected near the

Forestry building, having an engine room, 140 feet long by 87 feet wide, and separated therefrom by a brick wall is the boiler room of the same length, but only 60 feet in width. In erecting this building material was used, as far as possible, that could be disposed of to good advantage after the Exposition closes. Over the engine room is a roof of corrugated iron, while a common gravel roof shelters the boiler house.

The foundation consists of Portland cement concrete in the form of a single block, 140 feet long by 60 feet wide and 3 feet thick, resting on a double layer of planking, built of 4 by 12 inch plank, placed at right angles and securely spiked.

Five engines are employed in driving the Thomson-Houston multipolar generators; a 2,000 horse-power Reynolds-Corliss cross compound condensing engine, direct connected to a 1,500 kilowatt generator; a 750 horse-power Reynolds cross compound engine; a 750 horse-power Hammond-Williams compound condensing vertical engine, and a 750 horse-power Greene engine, are coupled direct to 500-kilowatt generators, and a 400 horse-power McIntosh & Seymour engine to a 200-kilowatt generator.

In the boiler room 10 Babcock & Wilcox boilers will supply the necessary steam. Greene's fuel economizers and fuel oil burners also form part of the equipment of the boiler house.

The problem of satisfactorily handling the great crowds of visitors that will gather at the stations and impatiently expect to be whirled away, has not been an easy one to solve, as there was little data at hand on which to base calculations. Even under a headway of a minute and a half, there will naturally be some loss of time, as few visitors will catch the hurried step of the educated "L" traveler, and a less number will have only the faintest idea of where they want to go, or at what station to leave the train. Fortunately the numerous side entrances facilitate the rapidity of loading and unloading. As the road has been constructed to meet many of the conditions presented in any large city, with proportionately the same grades and curves, it is to be hoped that its successful practical operation under the difficulties there encountered will result in the introduction of elevated electric roads in several of the large cities, where the majority of the street traffic is confined to a limited area, making it difficult and expensive to travel with any degree of rapidity.

THE ELECTRICITY BUILDING AND THE ELECTRICAL EXHIBITS.

CONTINUED.

Quite naturally the stars and stripes will crown all other flags, but in addition to our national colors, the flags of forty-six other countries will be flying in the breeze from the staffs on the main buildings, and together with hundreds of banners will form a brilliant and attractive symphony in color. In a general way these banners will indicate the character of the exhibits contained within the building, latest types of electrical apparatus being indicated in suitable designs on the banners flying above the Electricity building.

These brilliant decorative features also predominate within the Electricity building, where 100,000 yards of drapery form part of the general scheme of color and artistic decorations, the prevailing tints of the bunting used being light blue and cream that harmonizes with and softens the golden light of incandescent bulb and the whiter light of arc lamp, while from the archway at the north end of the building a woolen lambrequin, 80 by 58 feet, will be draped.

Much of this drapery is absolutely necessary to soften and subdue the unusual abundance of light that pours in from the 40,000 windows, lighting up the interior as no other exposition building was ever lighted before by sunlight.

In completing the work on the bunting required in all the buildings over 1,000,000 yards of material will be used, and electricity is the motive power used in driving the sewing machines.

The enormous amount of work required by the multitude and variety of details in connection with a department of the World's Fair is not generally appreciated. Not only must each department have a head to direct the policy, assume the responsibility and plan the arrangement, but there must be one whose mission is to see to the adherence of this policy, lighten this responsibility and carry these plans to a successful completion. In this capacity the public must be met, necessitating an individual possessing keenness of perception, tact, diplomacy and judgment to a high

degree, for, to adhere to a policy which has been formulated for the general good, must bring one more or less in conflict with that numerous class of people whose ideas of justice and equity are materially modified by being viewed through the spectacles of self-interest. And to lighten the responsibility of the head of the department, decisions must be made which will bear the scrutiny of further investigation and appeal. In the Department of Electricity this mission is ably fulfilled by Dr. J. Allan Hornsby, who was lately promoted to the assistant chieftainship of the department, on the recommendation of Chief Barrett.

Exhibitors from New York city, and from other points, too, have given expression to the pleasure experienced in calling at the offices of the Electrical Department, where all questions are quickly and squarely answered. There is no tendency to procrastinate or evade an issue, but decisions are rendered promptly and fairly, entirely on the merits of the question, with the admirable conciseness appreciated by the busy man. Exhibitors have found everything kept well in hand. Save some external decorations, the building is finished, the allotment of space completed, the installation of exhibits under way, and within the building, carpenters, painters and metal workers are erecting platforms, showcases and railings. Thus, it only remains with exhibitors to have everything in readiness when the opening occurs.

Still more gratifying is the constant and overwhelming demand for space that enables the department to sift out the most worthy exhibits, and to arrange a display that will prove interesting and instructive to the electrician, the manufacturer, the central station manager, and the student, as well as to the general public — a display worthy of the science and the industry, the educational features of which would be seriously marred had space been granted to every applicant, regardless of merit, or if all the space called for by fortunate exhibitors had been allowed, as in several cases the space asked for exceeded the total floor space occupied by the manufacturer at his factory or warerooms. Today, every important house in the electrical industry is a prospective exhibitor, and if one should drop out, five unsuccessful applicants stand ready to take his place.

THE TELEPHONE INTERESTS.

On February 7, science recorded another triumph in practically annihilating space and permitting oral communication between Chicago and Boston, over the long distance metallic circuits of the American Telephone & Telegraph Company. Governor Russell, of Massachusetts, heard plainly the musical greeting and the conversation of the gentlemen in the Chicago office 1,200 miles away. An achievement worthy of the Columbian year.

The Harrison Telephone Company, with its capital stock of $80,000,000, are actively engaged in reporting the enlistment of sympathy and capital, and propose to spend $10,000,000 for long distance circuits connecting the principal cities, and to avoid legal interference by using an automatic exchange, thus doing "away entirely with the telephone girl."

The Chicago *Evening Journal*, in commenting on the telephone question, states that "the American Bell Company has for years been fore-arming itself against the ides of March, 1893. By purchase and otherwise it has acquired the patent right of almost every practicable telephone transmitter and receiver. Hundreds of such patent rights, through which alone successful competition might come, lie securely locked in the safes of the big parent Bell company, never to see the light of day, it may be, unless the company adopts them for its own apparatus. These patent rights, which have been bought up by the Bell people from time to time, represent nearly every detail of telephonic improvement. Many of them were practically useless to the inventors in view of the existence of the Bell patent; many others possessed no intrinsic merit whatever; but all have been acquired with the idea of protecting the company from possible future competition, and of retaining the telephone monopoly in its hands."

And the *Journal* quotes Prof. Elisha Gray, the inventor of the Gray telephone, as follows: "Take a tree as the illustration of the patent system. There is the trunk—the broad basic patent covering the principle at stake, such as the telephone patent which expires next month; then there are the branches—the patents for essential parts of the apparatus, such as transmitters and receivers

in telephony; and again there are the twigs—subsidiary or auxiliary patents, covering the improvements made from time to time in minor features of the apparatus. You can extend the simile, if you will, to the leaves and buds of the tree—there are patents that may be likened to all of them. Every branch, twig, leaf and bud depends upon the trunk, and must draw its sustaining sap through that channel. So every telephone inventor who wished to make practical use of his invention, has either had to pay tribute in the shape of royalty to the Bell company, or to sell out his rights. Now the trunk of the telephone tree is about to disappear through the expiring of Bell's patent. There will be lots of sturdy branches left and plenty of twigs, but who will own the tree, do you think? You will find that almost every important patent, represented by those branches and twigs, is owned by the American Bell Company, and besides, it occupies the commercial field, which we may call the roots of the tree. There is, therefore, not much chance for successful competition, and consequent reduction of telephone charges just now, though I think that in the nature of things and the ordinary course of events, decreased charges will come by-and-by."

The attorney-general has begun action against the Bell Telephone Company to annul the patent issued to Emile Berliner, November 17, 1891. Commenting on the assertion that the solicitor for the telephone company, three years after the filing of the first specification "amended the application by striking out all the drawings then on file and substituting new ones, and striking out the entire specification except the preamble and signature, and substituting a new specification and claims, which was not, however, signed or sworn to by Berliner or verified under oath until long afterward," the attorney-general says:

"This amended specification was drawn with consummate art, and with intent, as your orator believes and charges, to mislead and deceive the examiner of the patent office by concealing from him the fact that the amendment introduced into the application a new and substantial invention not found in the original application."

The outcome of this suit may be to strengthen the validity of the Berliner and other leading patents. In any event, it is doubtful if any immediate change may be looked for, as the case has been postponed until August 25.

Of Pickernell and Carty, the well-known telephone experts, "Holland" writes thusly to the Chicago *Tribune*:

"One of the young electricians who took inspiration from Bell some years ago, and who turned aside from Harvard college to enter an electric laboratory, is J. J. Carty, who is of such high repute that he was summoned to London last fall to give advice to the company of which the Duke of Marlborough was the head, and which proposed to consolidate all the telephone systems of Great Britain, and to wipe out the plant of the old London Telephone Company, and replace it with a new one.

"Pickernell and Carty have made suggestions that before the end of the century, the cities of the entire United States will be in speaking distance of one another. The telephone is not expected to supplant the telegraph, but to supplement it, exactly as the telegraph has supplemented the postal service. There may be new companies. The Bell patents may possibly be overthrown. Monopoly in patents, or such monopoly as to give exclusive service may be lost, but the certainty that San Francisco can communicate with Chicago and New York, and that Philadelphia may talk with New Orleans or Seattle, is as much a part of the belief of these experts, as that the sun will rise on the first day of the next century.

"These young men do not say that the present companies have little fear of competition, but it is gossip that the companies which now control the business will, in the future, rely not so much upon patents perhaps, as upon the enormous capital which will be required to create other plants for telephonic service. Very rapidly earth circuit systems are being abandoned, and metallic circuits, whose first cost is much greater than that of earth circuits, are being substituted. The long distance telephone would be practically useless on the earth circuit system. Those who control the present plant, being in fact the Bell Company and its allied organizations, represent investment and property aggregating considerably more than $100,000,000, and it is inferred that this sum rather than any patents, is relied upon to protect what is called the monopoly in its business. Anybody can use a Morse instrument—at least the old kind—and anybody can put up a telegraph wire, but the Western Union is a monopoly, and the telephone companies which do business all over the country are associated together on similar principles with those which developed the Western Union Company. It may be a rival."

A SYNOPTICAL INDEX OF CURRENT ELECTRICAL LITERATURE.

ALTERNATING CURRENT APPARATUS.

(See Electro-Physics.)

"Non-Synchronous Motor for Ordinary Alternate Currents." By C E. L. Brown. *Electrical Engineer*, Feb. 8.

"The Action of the Tesla Motor." Letter from Prof. William A. Anthony. *Electrical Engineer*, Feb. 15.

"Reversibility of Three-Phase Motors with Inductive Winding." By Ernst Danielson. *Electrical World*, Jan. 21.

"The Calculation of Alternating Current Motors. — I." By E. Arnold. *Electrical World*, Jan. 21.

"Motors without Counter E. M. F." By W. (Correspondence and editor's comment.) *Electrical World*, Jan. 21.

"The Ewing High Frequency Alternator and Parsons Steam Turbine." By Nikola Tesla. (Reprint from the *Electrician*, London.) *Electrical Review*, Jan. 21.

"The Tension in Ferranti Cables." By Dr. Behn Eschenburg. (Reprint from *Electrotechnische Zeitschrift*, Nov. 4, 1892.) *Electrical World*, Jan. 21.

"Magnetrometric Method of Measuring Losses in Iron under Alternating Currents." By J. E. Moore. *Electrical World*, Feb. 4.

"Influence of Frequency on the Working of Alternate Current Transformers — I." By Charles Steinmetz. *Electrical Engineer*, Feb. 22.

"Experimental Researches on Alternate Current Transformer." By Dr. J. A. Fleming. (Abstract of a paper read before the London Institution of Electrical Engineers.) *Electrical World*, Dec. 24, Jan. 7, 21 and 28.

"Transformers." (Abstract of discussion of Doctor Fleming's paper.) *Electrical World*, Feb. 11.

ATMOSPHERIC ELECTRICITY.

"Report of Studies of Atmospheric Electricity." By Prof. T. C. Mendenhall. Member of the National Academy Sciences, Washington. (Note.) *American Meteorological Journal*, February.

"The Electrification of the Lower Air During Auroral Displays." By Alexander McAdie, M.A. *American Meteorological Journal*, February.

BATTERIES, STORAGE.

"Historical Sketch of the Storage Battery." By C. F. Uberlacher. (Abstract of a paper read before the Civil Engineers' Club, of Cleveland.) *Electrical Review*, Jan. 28 and Feb. 4.

"Home-Made Storage Battery for Electric Lighting Purposes." *Electrical World*, Feb. 11.

BIOGRAPHICAL.

"William Wallace and His Contributions to the Electrical Industries." By William J. Hammer. Part I, with portrait of William Wallace, and illustration of his private laboratory, etc. Part II, illustrating Wallace's first dynamo of 1874, the Wallace-Farmer dynamo, the Centennial arc light dynamo, etc. Part III, with illustrations of Wallace's dynamos of 1878 and 1879; the first arc lamp made in America; one of the first four arc lamps ever run in series, etc. Part IV, with illustrations of the Wallace plate lamp, the 48-carbon lamp, the 12-carbon lamp and experimental apparatus. *Electrical Engineer*, Feb. 1, 8, 15 and 22.

"The Death of Norvin Green" (with portrait). *Electrical World*, Feb. 18.

"Werner Von Siemens: Some Additional Details Regarding His Life and Work." *Electrical World*, Jan. 21.

"William Richardson" (with portrait). *Street Railway Review*, February.

"Walter P. Phillips" (with portrait), (United Press). *Electrical Age*, Jan. 21.

"H. M. Little" (with portrait). *Street Railway Journal*, February.

"The Life and Inventions of Edison." By A. and W. K. L. Dickson. Third paper. (A handsomely illustrated serial, the first paper appearing in the November number, with new portrait of Edison.) *Cassier's Magazine*, January. Fourth paper, February.

"John A. Coyle" (with portrait). *Street Railway Review*, January.

"Edison's Great Works." E. Jay Edwards. *Chicago News Record*, Feb. 4.

CENTRAL STATION, THE.

"Free Wiring." By J. M. Campbell. (A paper read before the Canadian Electrical Association at Toronto.) *Electrical World*, Feb. 4.

"Electrical Needs of the Times." By H. Franklin Watts. *Electrical World*, Jan. 21.

"Electrical Needs of the Times." By Lewis T. Robinson. (A brief reply to Mr. Watts' paper.) *Electrical World*, Feb. 4.

"Locating Trouble on Arc and Power Circuits in Central Station Work." By C. O. Pool. (A paper read before the Californian Electrical Society, San Francisco, Dec. 18.) *Stationary Engineer*, Jan. 21.

"Light and Power Stations—XIII." By Robb Mackie. (Suggestions for pole line and underground construction.) *Electrical Review*, Feb. 11.

"The Edison Electric Illuminating Company, of New York." (An annual report of unusual interest, prepared by Vice-President Bowker.) *Electrical World*, Feb. 4.

"Utter Lack of Business Principles." (Editorial comment on the published franchise asked for by the Hyndman E. L. & P. Co.) *Engineering News*, Feb. 2.

"The Steam Equipment of Modern Central Stations." By Alfred A. Hunting, M. E. (A paper read before the Thomson Scientific Club, Lynn, Mass., Jan. 26.) *Electricity*, Feb. 8.

"Electric Installations and Some Radical Changes in General Systems of Wiring." By C. G. Armstrong. (A paper read before the Chicago Electric Club, February 20, and illustrated with stereopticon views.) *Western Electrician*, March 4.

"Gas Power for Electric Lighting." (Abstract of a paper read by J. Emerson Dowson before the Institution of Civil Engineers, London.) *Scientific American Supplement*, No. 894, Feb. 18.

"The Electrical Side of St. Louis — III." (Description of electric lighting stations.) *Electrical World*, Feb. 25; Part IV, March 4.

DYNAMO ELECTRIC MACHINERY.

(See Biography. Hammer's, William Wallace.)

"Laminated or Divided Iron and other Metallic Masses in Electromagnetic Apparatus." By Thomas D. Lockwood. Part III, with portrait of Arago; Part IV, with portrait of Leon Foucault; Part V, with portrait of Faraday; Part VI, with portrait of Edward Weston. *Electrical Engineer*, Jan. 18 and 25, Feb. 1, 8, 15 and 22.

"Theoretical Elements of Electro Dynamo Machinery — XIV. By A. E. Kennelly. *Electrical Engineer*, Feb. 1 and 8.

"The Factor of Safety." (Editorial comment on insufficient armature insulation.) *Electricity*, Feb. 1.

"A Method of Correcting the Regulation Curves of Generators." By George L. Thayer. *Electrical Engineer*, Feb. 8.

"Calculation of a Small Electric Motor of 10 Kilogrammeters." By E. Meylan. Reprint from *L'Electrician*. *Electrical World*, Jan. 21 and 28.

"Shunt Motors." By W. D. Weaver. *Electrical World*, Feb. 25.

ELECTRO-THERAPEUTICS.

"Electricity: Its Application in Dental Practice." By Albert C. Westlake, D.D.S. (Abstract of paper read before the Dental Society of the State of New York.) *Electrical Age*, Jan. 21.

"Special Therapeutics of Static Electricity." By Frank Eddy Caldwell. *Journal of Electro-Therapeutics*, January.

"The Action of the Electric Current on Involuntary Muscles." Editorial. *Journal of Electro-Therapeutics*, January.

"Extraction of Steel from the Interior of the Eye with the Electro-Magnet." By Alvin A. Hubbell. *Buffalo Medical and Surgical Journal*, February.

Discussion on "The Relative Fœticidal Value of the Galvanic and Faradic Currents in Ectopic Gestation"; and

"The Treatment of Salpingitis by Depletion and Drainage, Secured by Electricity." By Dr. Augustin H. Goelet; and

"The Negative Pole of the Galvanic Current an Aid to Uterine Development, with Cases." By Dr. Charles G. Canady. *Electrical Review*, Jan. 28.

ELECTRO-PHYSICS.

"What Is Electricity?" By S. F. Walker. Reprint from the London *Electrical Engineer*. *Electrical Review*, Feb. 11.

"Alternate Currents of High Potential and High Frequency." By Nikola Tesla. (Author's Abstract in *Transactions*, of a lecture delivered Feb. 4, 1892, before the Royal Institution of Great Britain.) *Electrical Engineer*, Jan. 11, 18, 25.

"The Objective Representation of Hertz's Researches on Electrical Radiation." By L. Zehnder. (Abstract from Wiedmann's Annalen, No. 9, 1892.) *Electrical Age*, Jan. 28.

"The Physiological and Other Effects of High Frequency Currents." By Nikola Tesla. *Electrical Engineer*, Feb. 1.

"Luminous Discharges." By E. C. Rimington. *Electrical Engineer*, Feb. 1.

"Experiments in Electric and Magnetic Fields, Constant and Varying." (Reprint from *Engineering*.) *Electrical Engineer*, Feb. 8.

"Experiments in Electric and Magnetic Fields, Constant and Varying." By E. C. Rimington and Wythe Smith. (A paper read at the Physical Society, London.) *Electrical World*, Jan. 28.

"Electrical Oscillations of High Frequency." By Ervin S. Ferry. *Electrical World*, Feb. 4 and 11.

"Interference of Electrical Waves in a Metallic Circuit Illustrated by the Telephone." By M. R. Colson. *Electrical Review*, Jan. 21.

"The Transformation of Energy—Joule's Discovery." By V. E. Johnson, M.A. Abstract of article in *Westminster Review*, London. *Electrical Review*, Jan. 21.

"Tesla's Experiments Simplified." *Electrical Review*, Jan. 28.

"Electrostatic Motion." Abstract of article by M. Arno, of Turin, in the *Elektrotechnische Zeitschrift*. *Electrical World*, Feb. 4.

"High Frequency Discharges." (Abstract of article by Elihu Thomson in London *Electrician*.) *Electrical World*, Feb. 4.

ELECTRO-CHEMISTRY.

"Electro-Chemical Bleaching." Report of the Committee of Chemical Arts of the Society for the Promotion of National Industry. By Mr. De Luynes. Translated from *L'Industrie Electrique*. *Electricity*, Jan. 25.

"Practical Points from the Studios." (Etching by electricity; washing silver prints, etc.) Wilson's *Photographic Magazine*, February.

ELECTRO-CULTURE.

"Practical Farming by Electricity." By A. F. McKissick. (Details of electric system at the Alabama Agricultural Experiment Station at Auburn.) *Engineering Magazine*, February.

HEATING AND COOKING, ELECTRIC.

"Electrical Heating and Electric Metal Working." By George D. Burton. An address read before the Franklin Institute, January 18. *Electrical Review*, Feb. 11.

"Electric Heating." By G. Emil Hesse. *Electrical Age*, Feb. 4.

"Electricity in the Kitchen." (Editorial comment on comparative cost of operating electric and coal ranges.) *Electrical Review*, Feb. 11.

HEATING, STEAM.

"Economy of Heating with Exhaust Steam." By W. D. Weaver. *Heating and Ventilation*, Jan 15.

HISTORICAL.

(See Biographical. Hammer's, William Wallace.)
(See Dynamo Electric Machinery. Lockwood's article.)
(See Progress, Electric. President Preece's address.)

"Chronological History of Electricity — Part II. 1800 — 1820." By P. F. Mottelay. (With portraits of Ampère and Oersted.) *Electrical World*, Jan. 21 and Feb. 4.

INSULATION.

"Asbestos Porcelain." Reference to the new insulating compound devised by M. Garros. *Electricity*, Feb. 1.

"Note on the Disruptive Strength of Dielectrics." By Charles Proteus Steinmetz. *Transactions* American Institute of Electrical Engineers, February.

"Some Experiments with Disruptive Discharges." By Alexander Jay Wurts. *Electrical Engineer*, Feb. 15.

"Insulated Electric Conductors." By Dr. James B. Williams. Parts XVI, XVII, XVIII. *Electrical Engineer*, Jan. 18 and 25, Feb. 15.

"Experiments with High Frequency Electric Discharges." By A. A. C. Swinton. *Electrical Engineer*, Jan. 25.

"The Relative Advantages of Concentric and Double Cables." By M. E. Eden. *Electrical Engineer*, Jan. 18.

"Some Observations upon the Conductivity of a Copper Wire in Various Dielectrics." By Prof. Fernando Sanford, M.S. (Abstract from Leland Stanford, Junior, University publications, "Studies in Electricity.") *Electrical Engineer*, Feb. 8.

INSURANCE.

"The Subject of Fire Risks." By Walter F. Smith. And editorial comment. *Electricity*, Jan. 25.

LAMPS, INCANDESCENT.

"The Most Economical Age of Incandescent Lamps." By Carl Hering. *Transactions* American Institute Electrical Engineers, February.

"The Carbon Filament Lamp of 1859—The Story of an Overlooked Invention." By Franklin Leonard Pope. (With portrait of Henry Goebel, and illustrations of Goebel's "meat saw" type of lamp made in 1859, etc.) *Electrical Engineer*, Jan. 25.

"Incandescent Lamp Litigation—Henry Goebel, a New Claimant for Priority." (Abstract of affidavits presented, and editorial comment on the suit of the Edison vs. Beacon Company.) *Electrical Engineer*, Jan. 25, Feb. 1 and 8. Opinion of the court and editorial comment, Feb. 21.

"Another Claimant for the Incandescent Lamp." Editorial on the Goebel case. *Electrical Review*, Feb. 4.

"The Incandescent Lamp Situation." Editorial and summary of affidavits and decision in the Edison-Beacon suit. *Electricity*, Feb. 1, 8 and 22.

"The New Westinghouse Stopper Lamp." *Electrical Engineer*, Feb. 1.

"The Edison Lamp Patent." (Review of Edison-Beacon suit.) *Electrical World* (three illustrations and 8,000 words), Feb. 4; (11,000 words and two illustrations), Feb. 11.

"Concerning the Latest Claimant." By Park Benjamin. (Comment on certain features in the Goebel-Edison-Beacon case. By Park Benjamin.) *Electrical World*, Feb. 4.

"A Brief History of the Incandescent Lamp Situation." *Electrical World*, Feb. 18.

"The Economy of Incandescent Lamps." By L. K. Bohm. *Electrical World*, Feb. 4.

"The Incandescent Lamp." By R. G. Black. (Abstract of a paper read before the Canadian Electrical Association at Toronto.) *Electrical World*, Feb. 4.

"A New Method of Making Incandescent Lamp Filaments." (Reprint from *Zeitschrift für Electrotechnik*.) *Electrical Review*, Jan. 21.

MEASUREMENTS, ELECTRICAL.

(See Standards.)

"Electrical Measurements." By Prof. George D. Shepardson. (A practical article with illustrations of instruments used.) *Street Railway Review*, February.

"Paris 1881 and Chicago 1893." By G. Emil Hesse. (A plea for a universal system of measurements.) *Electricity*, Jan. 18.

"Electrical Measurements." By George Black. (Abstract of a paper read before the Canadian Electrical Association at Toronto.) *Electrical World*, Feb. 4.

"The Proper Use of Terms." By Carl Hering. *Electrical World*, Feb. 25.

MAIL CARRIERS, ELECTRIC.

"Electrical Mail Transportation in Cities." Comment on the Bryson device and the sale of Port-electrical stock. *Electrical Engineer*, Jan. 18.

METERS, ELECTRIC.

"Thomson Recording Wattmeter." By Parmalee J. McFadden. A paper read before the Chicago Electric Club, Jan. 16, and discussion. *Western Electrician*, Jan. 28, Feb. 4.

"Edison Meter." By John F. Gilchrist. A paper read before the Chicago Electric Club, Jan. 16, and discussion. *Western Electrician*, Jan. 28, Feb. 4.

"Aron Meter." By Charles Wirt. A paper read before the Chicago Electric Club, Jan. 16, and discussion. *Western Electrician*, Jan. 28 and Feb. 4.

"The Deflection and Control of Galvanometers." By E. Tremlett Carter. *Electricity*, Jan. 16.

"Electrical Recording Meters." Discussion of Caryl D. Haskins' paper. *Transactions* of American Institute of Electrical Engineers, February.

"Suggestions for Metering Devices." By S. D. Mott. *Electrical World*, Jan. 28. Feb. 11.

MINING, ELECTRIC.

"The Benefits of Electricity in Mining." By John McGhil. *Electrical Engineer*, Feb. 8.

"Report on the Present Applications of Electricity to Mining in Colorado." By Lewis C. Hill. *Mining Industry and Tradesman*, Jan. 26.

MUNICIPAL LIGHTING.

"Electric Street-Lighting in American Cities." The question of municipal versus private supply. By Robert J. Finley. *Review of* February.

"Municipal Electric Light Stations." Editorial comment on Finley's article in *Review of Reviews*. *Electricity*, Feb. 22.

"Recent Results of Municipal Gas-Making in the United States." By Edward W. Bemis. *Review of Reviews*, February.

"Street-Lighting in Boston Costs Too Much Money." (Proceedings of Boston Aldermen and Common Council; communication from the mayor proposing municipal control of lighting, etc.) Boston *Transcript*, Jan. 31.

PROGRESS, ELECTRICAL.

"Inaugural Address by William Henry Preece, F.R.S., President, The Institution of Electrical Engineers, London." (And editorial comment.) *Electrical World*, Feb. 18 and 25.

POWER TRANSMISSION.

"Probabilities as to the Success of Distribution of Power at Considerable Distances by High Tension Currents of Electricity." By E. Carl Breithaupt. (Abstract of a paper read before the Canadian Electrical Association, at Toronto.) *Electrical World*, Feb. 4.

"Transmission of Power by Direct Currents." (Comment on the Bradley system.) *Electrical Review*, Feb. 18.

"Three Million Horse-Power in Winter." By Robert Grimshaw, M.E. (Illustrated description of the Niagara Falls power plant.) *Cassier's Magazine*, January.

"The Utilization of Niagara." By Prof. George Forbes, F.R.S. Abstract of a paper read before the Society of Arts, London, giving complete details of the work accomplished and plans of the Cataract Construction Company. *Electrical Engineer*, Jan. 18 and 25.

"Recent Progress in the Introduction of the Triphase System." (Includes table of tests of six sizes standard triphase motors, and details of Heilbronn plant.) *Electrical World*, Jan. 21.

"A French Magnetic Towing Device." (Description of the Molinos-Bovert proposed system of river towage by magnetic adherence, presented at the French Congress on Industrial Navigation.) *Engineering News*, Feb. 2.

"Transmission of Power from Central Stations." Abstract of Professor Unwin's lecture before the London Society of Arts. *Electrical World*, Feb. 11.

RAILWAYS, ELECTRIC.

"The City Electric Street Railway Power Station of Little Rock, Ark., and Its Record." By B. J. Arnold, consulting engineer. (A paper read before the Engineers' Club of St. Louis, Dec. 7.) *Engineering News*, Jan. 26 and Feb. 9.

"Fuel Consumption on Electric and Steam Railways." (Editorial comment on B. J. Arnold's paper, giving comparative data on locomotive fuel consumption, and concluding that, while the electric road installed by Arnold does credit to the designer, that in regular railway service the electric motor cannot compete with the locomotive.) *Engineering News*, Feb. 9.

"Overhead Electric Tramways in England." By F. W. N. King. *Electricity*, Feb. 15.

"Sapless Cedar Block Paving." (Abstract of paper read by Thomas Appleton before the Western Society of Engineers, Chicago.) *Engineering News*, Feb. 2.

"State-Owned Railways in Australia." By Richard Speight, ex-chairman Victorian Railway commission. *Engineering Magazine.* February.

"Berlin Electric Railways." (Correspondence.) *Electrical Review,* Feb. 4.

"The Liverpool Elevated Electric Railway." By H. Scholey. *Electrical Engineer.* Feb. 15.

"The Acquisition of the Green Electric Railway Patents." (With comment on trolley patents.) *Electrical Engineer,* Feb. 8.

"The Electrical Side of St. Louis." (Detailed, illustrated description of electric street railway and electric lighting plants in St. Louis.) *Electrical World,* Feb. 4, 18 and 25, and March 4.

"Rapid Transit in Boston." (Editorial indorsement of Mr. Chester's suggestions.) *Street Railway Review.* February.

"One Large Versus Several Small Car Barns." (Views of managing officials.) *Street Railway Review,* February.

"Rail Bonding and the Ground Return." (Brief history of methods, present difficulties, and reports from leading roads throughout the country.) *Street Railway Review,* February.

RAILWAY PLANTS, ELECTRIC.

"The Los Angeles Consolidated Electric Railway." (Illustrated description, with portraits of M. H. Sherman and E. P. Clark.) *Street Railway Review,* February.

"Opening of the First Electric in New Orleans." (Illustrated description of the New Orleans and Carrollton system, with portrait of C. V. Haile.) *Street Railway Review,* February.

"McDonald's Broad Ripple Purchase." (Reference to the Indianapolis franchise, and brief biography and portrait of R. T. McDonald.) *Street Railway Review,* February.

"The New Line at Columbia, Pa." (With portrait of William Given.) *Street Railway Review,* February.

"Power Station of the New Haven and West Haven Street Railway, New Haven, Conn." By A. C. Shaw. *Electrical Engineer,* Feb. 1.

"The Wilmington City Railway." *Street Railway Journal,* February.

"Power Station of the Brooklyn & Newton Street Railway Company." *Street Railway Journal,* February.

"New York & Harlem Railroad." (The first street railroad in the world.) *Street Railway Journal,* January and February.

"Milwaukee, Minneapolis and St. Paul, Omaha, Council Bluffs." (Editorial comment and illustrated description of street railway systems in those cities.) *Street Railway Journal,* February.

"Lincoln Street Railway." *Street Railway Journal,* February.

"Eastern Station of the Brooklyn City Railroad Company." *Street Railway Journal,* February.

"La Fayette Electrics." *Street Railway Review*, January.

"Montreal's Street Railway System." *Street Railway Review*, January.

"Intramural Railway at the World's Fair Grounds." *Street Railway Review*, January.

STANDARDS, ELECTRICAL.

"Heating Effects of Alternating Currents." By A. D. Lunt. (Comment on note entitled "Alternating Current Ampère," in *Electrical World*, Jan. 7.) *Electrical World*, Feb. 11.

"The Future Ohm, Ampère and Volt." By Henry S. Carhart. *Science*, Feb. 7.

TELEGRAPH.

"The Theory of Submarine Cable Laying." By G. W. Littlehales. Parts I and II. *Electrical Engineer*, Feb. 15 and 22.

"Submarine Telegraph Enterprise." *Electrical Review*, Jan. 21.

SUBWAYS.

"New York's Electrical Subways." By William Maver, Jr. Part III, Gas in the Subways, the Blower Stations. *Electrical Engineer*, Jan. 18. Part IV, Comparative Cost of Maintenance and Advantages of Wires, Underground Wires Versus Wires Overhead in Cities, the Difficulties of Subway Construction, What the Subways Accomplish. *Electrical Engineer*, Jan. 25.

"Underground Construction." By W. A. Tower. (Abstract of a paper read before the Canadian Electrical Association at Toronto.) *Electrical World*, Feb. 4.

TELEPHONE.

(See Telegraph.)

"The New Orleans Telephone Exchange." *N. O. Picayune*, Jan. 29.

"Boston and Chicago United." (An illustrated description of the official opening of the Long Distance telephone line connecting Boston and Chicago, February 7, with portraits of Governor Russell and staff, De Wolf Hopper, A. S. Hibbard, F. A. Pickernell and J. J. Carty.) *Electrical Review*, Feb. 18.

"The Crowning Achievements of the Telephone." (Extended reference to the opening of the New York-Chicago and Boston-Chicago lines.) *Scientific American*, Feb. 18.

"Progress of Long Distance Telephony." (Abstract of the lecture before the New York Electrical Society by J. J. Carty and F. A. Pickernell.) *Scientific American*, Feb. 18.

"Expires in March." Extended review of telephone question with portraits of Bell and Gray. Chicago *Evening Journal*, Feb. 9.

"Charles Clamond's New Microphone." Description and discussion of Clamond's invention by P. Clemenceau, in the *Revue International de L'Electricata*, of Jan. 7, 1893. *Electrical Review*, Feb. 4.

"One Use for the Telephone." By F. S. Marsh. (For signalling to engine driver operating endless-rope haulage plant in mines.) Paper read before the Chesterfield and Midland Counties (England) Institution of Engineers. *Electricity*, Feb. 22.

"The Telephone Situation — I." *Electrical World*, Feb. 25.

"The Berliner Microphone Patent." *Scientific American*, Feb. 25.

TRAIN LIGHTING.

"Railway Train Electric Lighting in France." (Brief reference to experiments of Paris Northern Railway Company.) *Electrical World*, Feb. 4.

TRANSFORMERS.

(See Alternating Current Apparatus.)

WORLD'S FAIR.

"The World's Columbian Exposition of 1893." By James Dredge, member of the Royal British Commission. (A paper read before the Society of Arts, London, and illustrated with lantern slides.) Reprint from *Journal* of the Society. *Scientific American Supplement* No. 889, No. 890.

"Report of the Sub-Committee on Provisional Programme for the International Electrical Congress of 1893." *Transactions* American Institute Electrical Engineers, January.

"Supplement to Report of Sub-Committee on Provisional Programme." *Transactions* American Institute Electrical Engineers, February.

A BRIEF REVIEW OF SOME LEADING ARTICLES IN THE ELECTRICAL JOURNALS.

The first of a series of lectures by Prof. W. C. Unwin, on "The Development and Transmission of Power from Central Stations," was recently delivered before the Society of Arts. Professor Unwin stated that he thought there was a tendency to give undue prominence to electricity, which obscured the fact that there were other valuable methods of distributing power, and to seemingly overlook the fact that electricity is still dependent, in the majority of cases, on boilers and engines, which are usually just as necessary as the dynamo. The striking scientific success of an experiment furthermore is apt to obscure the commercial aspects, as in the Frankfort-Lauffen experiment, where the power as delivered actually cost five times as much as it could have been generated for on the spot in the ordinary manner. Practically there are only three sources of mechanical energy—the muscular energy of animals, the action of gravity on water falling from a height to which it has been raised by the sun's heat, and the heat derived from the combustion of fuel. The most important source of power is the consumption of solid fuel, but as this must be burned in an open grate, about one-fifth of the heat is wasted in the chimney. In transforming the heat into work by a steam engine, three-eighths of the heat in the steam is all that can be utilized, and this is still further reduced by the losses in the engine itself. Gas engines, on the other hand, work with a much greater temperature range than steam engines, and their thermal efficiency in practice is about double that of steam engines of large size; but ordinary illuminating gas is more expensive for a given heat value than coal. With gas made especially for power purposes, gas engines can probably compete on equal terms with steam. They are, however, very uneconomical at light loads. This is, however, also true of the steam engine, and while with the range of temperature available the steam engine may, on thermodynamic principles, turn into work three-eighths and the gas engine half of the heat energy supplied, no actual engines reach

these figures even approximately. The principal loss in both cases is caused by the cylinder walls abstracting heat from the working fluid, and this loss increases with the ratio of the admission surface in the cylinder to the weight of the working agent used. In the steam engine, therefore, the waste due to initial condensation must increase with light loads, because more surface is exposed per pound of steam used. In gas engines the action of the walls affect the efficiency at light loads still more unfavorably, and this is why initial compression of the expansive gas in the gas engine is necessary to good efficiency. The gas is reduced by pressure to a smaller volume, and is exposed to a smaller area of cylinder wall. It was calculated from experimental data that at full load it was possible to obtain an indicated horse-power with the expenditure of 1½ pounds of coal for a condensing engine, and 1¾ pounds for a non-condensing engine; but in practice Professor Unwin found that engines which should work with a consumption of 2 pounds of coal per hour used 2.7 pounds on a trial extending over many weeks. In electric lighting stations subject to a fluctuating load, results far more unfavorable were obtained. The Kensington station had a Willans non-condensing engine, which, on special trial, consumed less than 2 pounds of coal per effective horse-power. These engines, in 1886, used 7½ pounds of coal per effective horse-power per hour, and in 1891 3.8 pounds. In small isolated engines, working with a fluctuating load, still more extravagant results are obtained. From tables giving the consumption of engines in Birmingham, of from 4 to 24 horse-power, it was found they were using from 8½ pounds to 36 pounds of coal per horse-power hour. One cause of the large consumption figures obtained from central stations is probably due to the general practice of reckoning the fuel consumption from the indicated horse-power. At full load this is satisfactory, as the internal friction is then usually a small fraction of the total. Experiment has, however, shown that the internal friction is nearly constant for all loads, and hence, when the engine is lightly loaded, its mechanical efficiency is greatly reduced. At full load small engines have a mechanical efficiency of .80 to .85, and large engines may reach .90, but if the internal friction remains constant the actual efficiency will be greatly reduced for light loads. As the electrical engineer has a very exact means of determining the effective power supplied to his dynamo, he naturally reckons his

steam engines more by their effective horse-power than by their indicated horse-power. The first explanation of the high fuel consumption of engines working with a fluctuating load was, therefore, that the mechanical efficiency was lower than had commonly been supposed. The waste cannot be entirely explained by the action of the engine, however, but is partially caused by the irregular working of the boilers, the fluctuating load necessitating their continual heating up and cooling down again, and producing an inevitable waste, if not utilized by storage. As yet the uses of electrical storage are somewhat limited. Its cost is almost prohibitory, and, in many cases it is inapplicable, as for alternating currents. The cost of storage cells, without allowance for building, acids, etc., is about $39 per horse-power hour, stored, while gas storage costs about $1.32 per horse-power hour, stored. Mr. Druitt Halpin has worked out a method of storage which Professor Unwin thinks will play an important part in the future economics of the subject. This is a system of thermal storage in which water is to be raised to a high temperature. By reducing the pressure this heated water will give off steam at any rate of discharge required. He proposes to store this water in reservoirs at a temperature, when fully charged, of 406° Fahr., corresponding to a pressure of 265 pounds absolute. The engines are to work at a pressure of 130 pounds absolute, or 347° Fahr. Whenever the temperature in the heat storage reservoirs is above 347° they will supply steam to the engines automatically at any rate required. Fourteen and one-quarter pounds of heated water will supply 1 pound of steam, or allowing for losses, say 16 pounds of water per pound of steam are required at 130 pounds pressure. A simple cylindrical reservoir, 8 feet in diameter and 30 feet long, holding 84,000 pounds of heated water, will supply about 286 effective horse-power hours with a condensing engine, and about 210 horse-power hours with a non-condensing engine, and the cost of storage will be about $8 per effective horse-power hour, and $11 per effective horse-power hour respectively. While being more expensive than gas, this system is cheaper than the storage battery, and is worthy of the serious consideration of electrical engineers.

Professor Unwin, in his second lecture, gives further details of the Halpin system of thermal storage, and rather qualifies his previous indorsement by saying that while with a single boiler

and storage tank he thought everything would go on as Mr. Halpin supposed, when instead of one boiler and one tank there were many boilers and many tanks, there appeared some practical difficulties which had not been fully considered. One was to obtain a complete and rapid circulation, and the other was to insure that when the pressure was reduced at the top of the storage tanks the steam would be given off just where it was wanted, and not where it would embarass. In this system the boiler and storage tank are in free communication, the boilers are filled with water and the water-level in the storage tank is kept constant. The water is constantly being heated in the boiler and sent on into the storage tank; in the storage tank as steam is required it is given off, and the water consequently falls in temperature. From the storage tanks the cooled water, together with the feed, is constantly sent back to the boilers. The steam spaces in all the tanks are in communication, so that there is a uniform pressure in all the tanks. The steam required for working is taken off at the top of the storage tank through a reducing valve. Any reduction of pressure at the reducing valve will cause the steam to be generated at a rate depending on the difference of pressure. Some estimates were given which Mr. Halpin had made, showing the cost and saving of a commercial plant applied to an electric light station.

The lecture delivered by Professor Forbes before the Society of Arts on "The Utilization of Niagara" well illustrates the magnitude of this undertaking and shows in a striking manner the courage and ability with which the promoters have conducted the enterprise. The best engineering talent both in Europe and America has been consulted, and equal judgment and foresight has been shown in the management of the commercial side of the undertaking. Rights of way have been obtained for power tunnels on both sides of the river, giving the necessary facilities for the generation of 450,000 horse-power; considerable tracts of land have also been acquired for the erection of factories and workshops. Professor Forbes, who is the consulting electrical engineer of the enterprise, considered it inadvisable to publish details of the electric plant until the contracts have been let. The power generated will be transmitted electrically and it has practically been decided to use alternating currents. For some time this was

a disputed question, but as alternating current motors can now be obtained with a guaranteed efficiency of ninety-two per cent there is little doubt of their being adopted. Professor Forbes states that no less than twenty distinct plans for generators have been before him for consideration, some of them having moving portions weighing as much as sixty tons, while in others the weight was reduced to seven or eight tons. To develope the power the company has cut a canal 1,500 feet long and 500 feet wide by 12 feet deep; this starts at a point about one and a half miles above the American Falls. Along the edge wheel-pits have been sunk 160 feet deep at the bottom of which the turbines will be placed. The pits drain into a tunnel which forms the tail race. This tunnel is 6,700 feet long, and has a grade of about 0.7 foot per 1,000 feet. It discharges into the river below the Falls near the suspension bridge. The tunnel is horseshoe shaped, measuring 21 feet high by 19 feet wide inside the brickwork, its section being about 385 square feet. The amount of water to be carried off by the present tunnel will not exceed 10,000 cubic feet per second, and it is estimated that this quantity will not lower the depth of water over the crest of the falls by more than two inches. The turbines have been designed to give 5,000 horse-power under a head of 136 feet, the volume of water passing through the wheels being about 430 cubic feet per second, which is equivalent to about 6,500 horse-power, omitting losses in the down pipe, or with an efficiency of eighty per cent in the turbines the effective power will be a little more than 5,000 horse-power. The water is led to the turbines by a steel pipe 7 feet 6 inches in diameter. The driving shaft is 135 feet long and is made of steel tubes 38 inches in diameter, guide bearings are provided at intervals, and at these points the steel tube is replaced by a solid shaft 11 inches in diameter. This construction materially reduces the weight of the shaft necessary to transmit the power to the dynamo at the top. When at rest the weight of the shaft is carried by a bearing at the top, but when running the weight is supported by the water pressure acting on the under surface of the turbine wheel. The turbines are to be completed and in place by July 21, and it is hoped to have the dynamos completed by that time.

Professor Forbes, in his recent lecture on the "Utilization of Niagara," mentions a system of commutating alternating currents.

He does not go into detail at all, but states that many engineers are now working on a plan whereby the commutator, instead of being put upon the dynamo, is placed at the other end of the line, after the high-pressure alternating current has been reduced in pressure, thus enabling a low-pressure continuous current to be distributed to the motors at the distant station, while a high-pressure alternating current is used over the line. He does not state what system will be used, but says there are numerous methods which are available. Messrs. Hutin and Leblanc recently described the various methods for transforming alternating into continuous currents which they have experimented on. In their system the current is redressed by means of brushes revolving over a commutator, the commutator being revolved by a synchronous, alternating current motor. Almost all the systems thus far proposed possess this very undesirable feature of having revolving parts, and usually require that either the brushes or the commutator be revolved synchronously with the generator. It is very questionable whether such a system would be of much practical value.

Mr. W. H. Preece, in his presidential address before the Institution of Electrical Engineers, of London, comments upon the results obtained with the Chicago-New York long distance telephone circuit. It will be remembered that the telephone engineers figured the capacity resistance constant of this circuit to be three or four times the value at which Mr. Preece stated speech became impossible. Mr. Wetzler gave the capacity of this line as .0158 microfarads per mile. Mr. Preece considers this figure absurdly high, and would estimate the capacity of the line at about .004 microfarads per mile, and the K. R. constant at 7,500, which would give a result quite in accord with his former statements. Mr. Preece states that the quantity K. cannot be measured directly, as there are several modifications required, due to electro-static and electro-magnetic induction, which are at present beyond the reach of formulas, and which renders it difficult to determine the capacity, except approximately, from the telephonic effects themselves. The *Electrical World*, in an editorial, vigorously attacks Mr. Preece's statement. There is no question but what Mr. Preece is inclined to cling to his pet K. R. formula, more, it would seem, from sentiment than for scientific reasons. If the factor K. in the formula is not to be measured, or cannot

be determined except by experiment, it would be just as well to guess at the value of this constant to start with. Engineers are in the habit of measuring capacity by comparing it with a standard, the same as they would resistance, and while there are unquestionable inductive effects which modify the value, it is hardly fair to jumble all these together and call them K. It would be far simpler to admit the inaccuracy of the K. R. formula to start with, or at least to introduce factors or coefficients which are to be determined by experiment.

The economy in using gas engines for electric lighting has been very prominently brought forward recently by a number of papers read before the engineering societies abroad. Mr. Dowson, in a recent paper read before the Institution of Civil Engineers, London, stated that an aggregate of 7,000 horse-power of gas engines were used in Great Britain, and that in Germany gas engines were used for about 1,100 arc and 90,000 incandescent lamps. He states that with a large gas engine one brake horse-power per hour can be obtained with a consumption of one pound of anthracite or 1⅓ pounds of coke, whereas the consumption of coal with the steam engines used for central stations must be taken at about 2½ pounds per brake horse-power when working under a full load. The late Sir William Siemens was probably the first to draw attention to the fact that when illuminating gas was used in a gas engine to drive a dynamo, much more light was produced electrically than could be produced by burning the same quantity of gas in burners in the usual way. With 47 cubic feet of gas required per kilowatt and 55 watts per 16 candle-power lamp, one lamp will require only $2\frac{6}{10}$ cubic feet of gas per hour, whereas a standard Argand burner requires 5 cubic feet per hour. M. Witz has brought the matter before the French engineers by a paper read before the Society Industrielle du Nord. In tests which he carried out at Rouen two years ago, a 100 horse-power gas engine was found to consume $1\frac{32}{100}$ pounds of anthracite per effective horse-power hour. M. Witz points out that the gas engines give a gain of twenty-eight per cent in efficiency over the best constructed steam engines. Mr. Thwaite, in a paper read before the Manchester Association of Engineers, proposes to use gas engines and claims that a horse-power can be produced with an expenditure of from ⅝ to one pound of solid fuel. From these results it

would seem that the gas engine is to play an important part in the future of power production. The chief disadvantages in connection with its use heretofore have been its irregular action and general unreliability.

In the *Electrical Engineer*, Mr. A. A. C. Swinton describes some experiments with high frequency electric discharges, in which sufficient electricity was passed through the body of the experimenter to bring the filament of an ordinary incandescent lamp to very nearly full incandescence. Practically no sensation was experienced. The apparatus employed consisted of a large apps induction coil, capable of giving ten-inch sparks, supplied with current through the ordinary vibrating contact breaker, and a resistance consisting of eight 50 candle-power lamps in parallel from a 105-volt continuous current supply. To produce a similar incandescence of the filament with continuous or alternating currents of ordinary frequency would require about one-fifth of an ampère, and at first sight it would seem that this quantity of current might pass through the arms and body of the experimenter. It has been generally assumed that with high frequency currents the current is rendered harmless by reason of the high frequency. In fact, that high frequency renders harmless to the human body currents of a strength that would be dangerous and painful, if not fatal, were the frequency lower. Mr. Swinton is inclined to think that another explanation is possible, and that the true fact is, not that high frequency renders harmless a given strength of current that with ordinary frequency would be harmful, but that with high frequency it is possible to obtain effects with exceedingly small currents that with continuous or ordinary alternating currents can only be obtained by the use of much larger currents. In other words, the high pressure used requires a very little current to produce a considerable amount of energy. The explanation is applicable to many other high frequency effects, but as applied to the lamp experiment is simply that the lamp filament, having a certain definite resistance with continuous or ordinary alternating currents which pass uniformly, or nearly so, through the entire section of the filament, requires a considerable ampèrage of current to produce the number of watts required to raise the filament to incandescence. With the high frequency currents, on the other hand, the current travels chiefly on the outer surface of

the filament, little or none passing through the central portion, the current is, in fact, merely skin-deep. The actual resistance, therefore, is very high, as only an extremely small portion of the filament acts as a conductor. With the extremely high pressure used a very minute current is sufficient to produce the number of watts required to raise the filament to incandescence. The lamp, in fact, ceases to be a 100-volt lamp and becomes a 100,000-volt lamp. As confirming this, sparks were noticed passing between the lamp terminals which were at some distance apart, this being conclusive evidence that there was a difference of potential of thousands of volts between the two ends of the filament. The explanation of the phenomena offered by Mr. Swinton is the one almost universally accepted by scientists. Professor Thomson carried out a number of similar experiments and came to the same conclusion that Mr. Swinton did. Professor Thomson's experiments show that high frequency discharges are not by any means harmless, as it was found that a kitten placed in the path of a heavy discharge was instantly killed, and that while an increase of frequency may lessen the danger to life, as shown by some experiments, there is no certainty but that at some still higher frequency increased danger may exist, and for the present, at least, we must come to the conclusion that wherever high frequency currents have apparently been harmless there has simply not been enough current to do any harm.

Mr. Tesla, in a letter to the *Electrical Engineer*, referring to Mr. Swinton's article, states that he has never considered the current's *strength*, but the *energy* the human body was capable of receiving without injury, and that he has expressed clearly on more than one occasion that the higher the *frequency*, the greater the amount of electrical *energy* that may be passed through the body without serious discomfort. It would seem, then, that there was no conclusive proof that for a given amount of current there is less danger at high frequency than at that ordinarily met with in every-day practice.

Mr. C. E. L. Brown, in the *Electrical Engineer*, describes a new type of non-synchronous motor for ordinary alternate currents. It possesses all the characteristics of the multiphase current motors, there are no collectors or brushes, and the motor is consequently very simple. It is based on the principle which

Mr. Brown claims to have discovered, that a conductor in an alternating field if set rotating will itself run up to practically synchronous speed. By modifying the form of the armature and conductors almost exact synchronism can be produced, or, the speed can be made below that of synchronism. The direction of rotation is indeterminate, depending on how the motor is started. Particular pains are taken to reduce the magnetic resistances to a minimum, and to accomplish this, laminated iron cores are used for both the induced and inducing windings, the wires being embedded in the iron. One form of this motor is precisely like the three-phase motors described in connection with the Lauffen-Frankfort transmission. Indeed the motor seems to be based on the discovery that certain motors made for multiphase currents also run with simple alternating currents. In reviewing the present position of the alternating motor problem, the London *Electrician* briefly sums up the work of the different inventors. The original idea was that any motor would work with alternating currents if both the field magnets and armature were laminated, but it was soon found that the output was almost nil. Dr. Hopkinson, in his historical lecture in 1883, showed that an ordinary alternating dynamo would run as a motor synchronously with a generating dynamo. Prof. Elihu Thomson then struck a new vein in his induction motor in which alternations of magnetism in the magnetic circuit set up by a magnetizing current produced currents in the rotating armature. By means of various devices this current was made to produce a rotary effort. The Tesla motor and all multiphase motors are particular devices for producing an induction current in a rotating coil capable of giving a rotary effort. The motor of Mr. Brown is another particular case of this class of motor. The Tesla motor was brought forward in 1887, and for a time was thought to be the solution of the question. Next the Gantz alternating motor was brought out. This turned out to be a synchronous motor with a commutating device for rectifying the magnetizing currents of the field magnets to make the motor self-starting. Since then no real novelty of principle in alternating motors has been developed. What has taken place has been to improve, combine and adapt for specific purposes. Whether the solution proposed by Mr. Brown is the final one remains to be seen, but all indications at present point to the induction motor invented by Prof. Elihu Thomson as the motor of the future.

What particular device will be adopted to produce the rotating effort by placing the active motor coil in an unsymmetrical position regarding the field remains to be seen. The arrangement of Mr. Brown, depending on the rotation of the coil itself into an unsymmetrical position after the magnetic induction has acted, is certainly simple and at all events opens up a new branch.

Owing to a misunderstanding the Review of Leading Articles in the last issue was allowed to go to press without the proof being corrected, and the following errors therein are noted: Page 83, twenty-fifth line, in place of "not to be deprecated" should read "to be deprecated." Page 85, twelfth line, in place of "more than 1s. 3d. per kilowatt" should read "more than ⅓d. per kilowatt." Page 88, sixteenth line, in place of "simple transformer," should read "single transformer." Page 101, second line from bottom, in place of "28 cents per horse-power hour" should read ".28 cents per horse-power hour."

NEW PUBLICATIONS.

THE STORY OF THE ATLANTIC TELEGRAPH. By Dr. Henry M. Field. With portrait of the late Cyrus W. Field; 5½ by 8; 415 pages; $1.50. Charles Scribner's Sons, 743 Broadway, New York.

A thoughtful, earnest tribute to the public-spirited enterprise of Cyrus Field, and though the laying of the cable is an old and oft-told tale, yet never were the threads of cold facts so skillfully gathered and so charmingly interwoven as in this "Story of the Atlantic Telegraph." In the opening chapter, where we learn of the inception of the plan that later on is to unite the nations of the earth in telegraphic communication, our sympathies are awakened and we follow Mr. Field through the twelve long years of earnest, ceaseless labors that were finally crowned with success; grieve over the loss of the first cable almost as deeply as though we, too, were on the Niagara; rejoice over the final outcome of this wonderful achievement; and turn the last leaf with a feeling of pride that it was a public-spirited American who enlarged in so wonderful a manner the sphere of human activity. F. DE L.

ELECTRICAL PATENTS.

ISSUED JANUARY 24, JANUARY 31, FEBRUARY 7 AND FEBRUARY 14.

This list is intended to include all electrical patents which are noteworthy. It is not a complete list of all patents.

491,491.—*Insulated Magnetic Coil.* Thomas E. Morford.

The conductors of the coil are embedded in an insulating enamel.

491,490.—*Insulation of Dynamo Armatures.* Thomas E. Morford.

The conductors of the armature coils are embedded in an insulating enamel.

490,810.—*Dynamo Electric Machine or Electric Motor.* Edward H. Johnson.

The machine is provided with a disk armature and a pair of field magnet coils, lying one upon each side of the armature, and in planes parallel to it.

491,567.—*Conductor for Armatures.* F. Kolben.

The conductor is designed for armatures in which currents of large volume are induced, and, in order to prevent the formation of eddy currents, the conductors are provided with sawkerfs lying in radial planes, thus presenting narrow faces to the pole pieces.

490,809.—*Dynamo Electric Machine.* R. Lundell.

The dynamo electric machine is provided with a disk armature and a single field magnet coil which lies upon one side of the armature and in a plane parallel to it. The field takes the shape of a ring with a hollow core, within which is placed the exciting coil.

491,294.—*Dynamo Electric Machine.* G. V. M. A. Parrot and A. C. Reignier.

The armature conductors are composed of a magnetic metal and an electric conductive material, as iron and copper, superposed and welded together. These conductors are wound upon a

core containing no magnetic material. The iron in the armature conductors serves the purpose of the iron core of the ordinary armature, that of furnishing a path for the lines of force of the magnetic field, while at the same time currents induced in the iron, analogous to the Foucault currents of the ordinary armature core, will be in the direction of the currents induced in the copper, and will be conducted to the latter and will assist in supplying the working circuit.

491,106.—*Bipolar Electrical Machine.* Thomas H. Hicks.

The machine is of the bipolar compound self-exciting alternating type, and is provided with two commutators and a pair of collecting rings, one commutator being provided with brushes included in circuit with the shunt winding. The main current passes to a collecting ring, out over the working circuit, back to a two part commutator where it is commutated and passes through the series winding of the machine as a direct current, then passing back to the commutator, where it is again transformed into an alternating current.

492,036.—*Automatic Circuit Breaker for Motors.* Robert T. Lozier.

The circuit breaker is designed for shunt-wound motors, in which it is customary to interpose a resistance in the armature circuit, until the speed has sufficiently increased to generate a back electro-motive force of proper value. Should the speed of the motor be afterward decreased, or the motor stop, unless the resistance is again interposed in the circuit before the normal current supply is resumed, the excess of current may damage the armature. As the resistance is usually interposed manually, it is desirous to provide for the contingency of the counter electro-motive force of the motor falling when the attendant is not at hand, and this is provided for by opening the armature circuit, thus stopping the motor. A switch is provided which will automatically open the main motor circuit when the strength of the motor's field-magnets has weakened sufficiently to reduce the counter electro-motive force of the armature to such a point that the initial electro-motive force, when resumed, would otherwise transmit an excess of current through the armature, thus permitting the attendant to properly adjust the rheostat before again starting the motor.

492,176.—*Commutator for Dynamos or Motors.* Joseph A. Williams.

Slots are provided between the segments, which open into longitudinal chambers adapted to communicate at the proper time with the mains of an air compression pump. As the slot passes from beneath the brush, a current of air is directed outward that acts to blow out any spark that may have formed between the brush and the receding commutator segment.

492,244.—*Method of Constructing Armature Cores for Electric Motors or Dynamos.* Albert W. Smith.

The armature, which is of the Gramme ring type, is built up from sectors of magnetic material. The edges upon the interior surface of the ring are then welded together by means of the electric arc, thus securing the sectors rigidly together without the use of bolts. As the inner edges of the sectors cut no lines of force, no eddy currents are obtained by thus rendering the inner surface of the ring integral.

490,297.—*Electric Railway Conductor.* H. A. Miner.

The feeder wire is suspended immediately above and in close proximity with the trolley wire and serves by the aid of a partial inclosing case as a support and guide, and also as a feeder for the trolley wire. The casing is of non-conducting material and completely covers both wires, except a narrow space directly beneath the trolley wire. The trolley wheel is provided with a central web that extends into the opening in the inclosing case and makes contact with the trolley wire.

490,306.—*Closed Conduit for Electric Railways.* R. Parker and B. F. Sutton.

The conduit is designed for systems in which the trolley wheel is adapted to exert an upward pressure. The feeding conductor is contained within a flexible tube, and is retained at the upper side of the tube by means of clamps that also serve to support the flexible tube in position. To the lower external side of the flexible tube is secured the trolley conductor, formed in sections and provided with extensions passing through the walls of the flexible tube. When the trolley wheel bears upon the sectional conductor, the latter is raised into contact with the feeding conductor, the elastic wall of the flexible tube permitting the necessary motion.

491,857.—*Electric Locomotive.* F. B. Rae.

The motor is carried between the two axles of the truck and occupies a position in which its armature shaft is perpendicular to the wheel axles. Upon each end of the armature shaft is provided a bevel pinion, the pinions meshing with bevel gears upon the car axles.

491,132.—*Inclosed Conductor for Electric Railways.* Frank C. Perkins.

An insulated feed conductor is inclosed within a flexible metallic tube and is normally out of contact with it. As the trolley passes, the flexible portion of the metallic inclosing tube is pressed against the feed conductor, thus closing circuit between the feed conductor and the trolley-wheel.

491,988.—*Electric Railway Trolley.* A. Dickinson.

The trolley wire is supported from brackets carried upon poles set at the curbing. The track may be at the middle of the street, and upon the car is provided an upright post, to the upper end of which is journalled the trolley pole which carries upon its end the trolley wheel. The trolley pole thus extends obliquely to the vertical in a plane approximately at right angles to the direction of motion of the car.

490,975.—*Electric Railway.* E. W. Mitchell.

The feed wire is inclosed within an insulating covering having openings at intervals. A sectional service conductor extends parallel to the feed wire and is composed of rigidly connected insulated sections, each section being provided with a plurality of contacts adapted to establish connection with the feed wire. Means are provided for yieldingly holding the contacts normally out of contact with the feed wire.

491,666.—*Electric Locomotive.* Sidney H. Short.

The motor is supported upon the axle of the truck and is connected at one point with the frame of the truck through a buffer. The field coils are two in number and placed one upon each side of the armature and co-axial with it, and are adapted to supply lines of force to a number of pole pieces. Between the axle and the felloes of the wheels is interposed an insulating and cushioning material. The armature of the motor is geared directly to the wheels.

492,265.—*Conduit Electric Railway.* Fred. W. Braun.

The trolley wire is carried beneath a small gable roof extending along the side of the conduit. The roof is made of insulating material, and upon its under side is provided with downwardly extending arms, to the lower ends of which is attached the trolley wire. The trolley wire is thus protected from water that may enter the conduit through the slot.

491,691.—*Series System for Railways.* George L. Thomas.

The suspended supply conductor is composed of relatively insulated sections, which are normally in electrical connection through a pair of metallic rollers yieldingly held in contact by a spring, the rollers being connected respectively with the ends of adjacent sections. Upon the car is carried a bar composed of metallic plates separated by insulation, the motor being connected between the two plates. As the car progresses, the bar, which is pointed at the ends, passes between the rollers which make contact with the metallic plates and thus include the motor in series with the supply conductor. The pairs of rollers are placed at such a distance apart that the bar makes connection with one pair of rollers before the connection with the preceding pair is broken.

491,684.—*Manufacture of Secondary Battery Electrodes.* R. McA. Lloyd.

The manufacture consists in subjecting a plate to the action of a solution which is acid in the beginning, and which afterward becomes alkaline, thus first producing honeycombs in the surface of the plate, and subsequently chemically depositing on the plate active material. Afterward the plate is formed by the passage through it of an electric current.

490,953.—*Art of Generating Electricity.* Thomas A. Edison.

The art consists in causing the dry decomposition of a chemical compound in a rarefied atmosphere and in the presence of a positive element which is attacked and electrically charged by such compound, and a negative element which is electrically charged by the dry chemical reaction. Oxide of iron may be used as the chemical compound, and is reduced in the presence of a carbon positive electrode by the application of heat, the product of the decomposition being carbon dioxide, which is removed by a vacuum pump to maintain a rarefied atmosphere.

491,095.—*Electric Arc Lamp.* W. E. Freeman.

A centrally pivoted lever carries upon its ends the armatures or cores of the series and shunt electro-magnetic devices, and is provided with a cam that engages with and regulates the action of the carbon clutch in grasping and releasing the carbon rod.

491,124.—*Arc Light Carbon.* James McLaughlin.

The carbon is provided with a plurality of separated members integrally joined together at one end. Two such carbons are placed opposite one another, and, in burning, the arc automatically shifts from one pair of members to another as the resistances of the paths change.

492,200.—*Electric Arc Lamp.* Henry Harper.

A differentially wound solenoid is provided with a hollow core within, which works a stationary piston suspended from the top of the lamp. The upper end of the core presents but a limited passage to the air, so that the piston working within the core acts to damp the motion of the core. The upper carbon is attracted to the lower end of the core.

491,604.—*Electric Arc Lamp.* Charles E. Scribner.

Yielding guides are provided for the upper carbon rod, and upon one of the guides is carried one of a pair of contact points, the other one being stationary and normally out of contact with the one on the guide. When, at any time, the yielding guides support the whole or any considerable amount of the weight of the upper carbon rod, the guides yield to permit the closing of the contact points. The contact points are included in a shunt circuit about the carbons, and when closed serve to shunt the carbons.

491,605.—*Cut-out for Arc Lamps.* Charles E. Scribner.

An electro-magnet is included in series with the carbons of the lamp, and, under normal conditions of the burning of the lamp, is sufficiently excited to attract its spring-pressed armature to maintain a short circuit about the carbons open. When the current through the carbons materially decreases, the armature is released to close the short circuit in which is included a resistance. The closing of this short circuit breaks the arc, thus de-energizing the feeding magnets and permitting a permanent short circuit containing no resistance to close.

491,251.—*Duplex Electric Arc Lamp.* Charles E. Scribner.

An electro-magnetic device is connected with one of the lower carbon supports, and is so connected with the circuit of the lamp that the support will be lowered when the lamp is first brought into service, and raised again, carrying with it both the upper carbons, the operation being repeated each time the arc is shifted. The amount of carbon that is consumed between each shifting of the arc is determined by the length of the stroke of the movable support.

492,312.—*Electric Arc Lamp.* J. Thompson.

The carbons are mounted at right angles to one another, both carbons being supported upon longitudinally movable carbon rods. The horizontal carbon rod is carried upon a pivoted lever, to the end of which is attached the core of a solenoid, the action of which regulates the arc. The horizontal carbon extends over the vertical rod and is made the positive electrode, so that the light from the crater formed in the positive electrode is unobstructed by the negative electrode.

491,548.—*Electric Arc Lamp.* F. D. A. Goold.

When not burning, the carbons rest out of contact, and a magnet is provided in shunt of the arc which performs the function of properly feeding the carbons during the burning of the lamp. The upper carbon rod, which is the movable one, is normally held from feeding by a clutch suspended from one end of a lever, to the other end of which is attached the weighted armature of the magnet. When current traverses the lamp the magnet is energized, thus attracting its armature, the motion of which brings the carbons together. A shunt circuit of low resistance being thus formed around the magnet, the latter is de-energized and its armature is permitted to descend, thus raising the carbon rod and establishing the arc. During the burning of the lamp, when the arc becomes abnormally long, the magnet is energized to attract its armature, thus permitting the carbon rod to feed until the resistance of the arc is properly diminished, when, the current through the shunt magnet being insufficient to retain the weighted armature in a raised position, the latter falls, thus locking the carbon rod in position.

491,682.—*Bushing for Incandescent Lamp Sockets.* C. A. B. Halvorson.

The bushing is designed for pendant lamps, and comprises a cork provided with a longitudinal opening adapted to permit the passage of the cord containing the conductors. The yielding character of the cork prevents the cutting of the cord while properly insulating it from the lamp socket.

491,603.—*Duplex Electric Arc Lamp.* Charles E. Scribner.

Two lamps are connected in multiple in the same circuit, and a shunt is provided about both lamps and contains the cut-outs of both so that the lamp first to burn serves to open the shunt circuit. Each lamp is provided with a circuit-closing device controlled by its lifting mechanism, the contact points of each circuit-closing device being placed reciprocally in that part of the multiple circuit leading to the carbons of the other lamp, so that the movement of the lifting mechanism of one lamp will hold open the circuit of the other lamp. Normally the carbons of both lamps rest in contact, and when current traverses the circuit the lifting mechanism of one lamp will act a short time before the other and will thus open the circuit of the tardy lamp. Farther motion of the lifting mechanism serves to open the shunt circuit, and the arc is formed.

490,992.—*Electric Arc Lamp.* J. Sugden and W. J. L. Sandy.

The lower carbon is supported upon the core of a solenoid placed in series with the carbons, and the solenoid when excited acts to draw down the carbon against the tension of a coiled spring. The upper carbon is suspended from a piston working in a closed air tube and has a constant tendency to descend, but is normally prevented from descending by means of a brake wheel held against the carbon rod by the armature of an electro-magnet included in series with the carbons. Normally the carbon points rest in contact, and upon passing a current through the lamp, the solenoid is excited to draw down the lower carbon, the electro-magnet at the same time being excited to lock the upper carbon rod in position. The arc is thus established, and, when its length becomes abnormal, the electro-magnet is weakened and the brake is released, thus permitting the air-pressed piston to feed the carbon rod.

492,150.—*Process of Coating Conductors for Incandescent Lamps.* Thomas A. Edison.

The filament is embedded in insulating oxide, or compound, contained in a suitable receptacle, after which the air is exhausted from the receptacle, and finally a current of electricity is passed through the filament.

490,954.—*Manufacture of Carbon Filaments for Electric Lamps.* Thomas A. Edison.

The manufacture consists in forming filaments of carbonizable material, maintaining them in the desired shape and partially carbonizing them before they have been soaked, then filling the pores of the filaments by soaking them in liquid carbonizing material and finally completely carbonizing the filaments.

491,992.—*Cut-out for Incandescent Lamps.* T. A. Edison.

The cut-out is designed for lamps used in series circuits. Upon the breaking of the filament an arc is usually formed between the wires inside the lamp globe, which follows down the wires, rupturing the glass seal and permitting air to enter the globe. In the base of the lamp is provided a small cylinder and piston, the piston being moved by the passage of air to the globe to release a spring that closes a permanent short circuit about the filament.

491,109.—*Telephone Cable.* Silas W. Holman.

The cable is composed of strands of two wires, the strands being twisted together so that the pitch of the twist in adjacent strands varies in order that inductive effects between the wires of adjacent strands may be prevented.

491,252.—*Metallic Circuit for Multiple Switch Board Systems.* John A. Seely.

A ground connection is provided for both branches of a metallic circuit at the subscriber's station, so that the ordinary call may be made over one limb of the circuit, while the other limb, connected with the insulated frames of the different switches of the line, may be used as a test wire. When the subscriber takes his telephone from the switch, this ground connection is broken at the subscriber's station, and the two branches or limbs are united to form a metallic circuit which is completed at the central office through a pair of loop plugs and cords.

491,275.—*Telephone Transmitter.* Harry L. Tyler.

The diaphragm carries upon its back a hook to which is secured one end of a chain composed of carbon links, the other end of the chain being supported upon an adjustable slide. The vibrations of the diaphragm serve to alter the pressure between the adjacent links of the chain to change the resistance of the circuit containing the chain.

491,250.—*Testing Apparatus for Multiple Switch Board Systems.* Charles E. Scribner.

A test battery is placed in circuit with that strand of the cord which connects with the sleeve of the plug, a winding of the clearing out annunciator being also included in the circuit. In this manner the clearing out annunciator may be made to perform its function, and in addition permits the test battery to be applied in a ground branch without destroying the balance as between the two sides of a metallic circuit.

491,688.—*Switching System for Telephone Exchange.* Charles E. Scribner.

Each busy line or frequently called subscriber's line is connected with a line spring jack upon each section of a multiple switch board system and with an answering jack and an individual annunciator upon some one section of the switch board as heretofore. The remainder of the lines, the seldom called for lines, are connected with line springs upon a separate switch board and with answering jacks and annunciators upon some section of the main multiple switch board. Transfer or trunking systems are provided, extending from the various sections of the main switch board to the auxiliary switch board, by means of which connection may be established from any line at the main switch board to the auxiliary board.

492,219.—*Lightning Conductor and Arrester.* A. B. Lyman.

The armature of a magnet is carried upon a pivoted lever which, when moved, acts to insert a piece of asbestos carried upon its end between a pair of carbon electrodes, across which the static discharge leaps. At the same time the motion of the lever imparts to the supports for the carbon electrodes such a motion that the electrodes are caused to recede from one another. The spark is thus destroyed, and the passage of generated currents across the spark interrupted.

490,762.—*Electric Circuit Breaker.* E. M. Bentley.

The circuit breaker is provided with means for extinguishing the spark formed when the circuit is broken, and consists in an air pump or compressor actuated by the moving member of the circuit breaker, by which a stream of air is forced across the spark gap at the terminals upon rupture of the circuit.

490,700.—*Electrical Measuring Instrument.* Edward Weston.

The instrument is of that type in which a body, usually a fine wire, is expanded by the action of the current to be measured, the extent of expansion being indicated upon a suitable scale by means of a pointer. The invention embodies a support for the expansive body having the same coefficient of expansion as the expansible body, so that any variation in dimension of the expansible body caused by exterior influences, such as changes in atmospheric temperature, will be compensated for by the like change in dimension of the support, due to the same cause.

490,698. — *Electrical Time Indicating Apparatus.* Edward Weston.

The indicating apparatus comprises means for regulating clocks at a distance by means of electricity, without the intervention of contact points in the electric circuit. In systems as often used, a vibrating pendulum or similar device is adapted to periodically make and break the circuit through an electro-magnetic device at the point of regulation. In the apparatus of the invention a loop conductor is adapted to be mechanically moved in a field of force, and is connected in circuit with a second loop conductor, also movable in a field of force, which second conductor controls by its movement the movement of the indicating mechanism, commonly a clock. The first conductor is the coil of a single-coil armature that is adapted to rotate between the pole pieces of a field magnet, and during each revolution of the armature two pulsations are sent over the line connected in circuit with the armature coil. This pulsating current traversing the second coil, which is located in a field of force, will cause the latter to oscillate, and as the second coil is connected with the escapement of the clock train, the latter will be permitted to act, to move the hands over the clock dial. By varying the speed of the motor armature the length of the periodic time may be regulated.

491,457.—*Electrical Measuring Instrument.* R. G. Willyoung.

The needle is supported in pivot bearings, and is made dead beat by the employment of a piston and air cylinder so that the needle will not swing beyond the proper point of deflection.

491,560.—*Coulomb Counter.* G. Hummel.

The stationary field coils of an electric motor are traversed by the current to be measured, and the movable armature coils are included in a shunt circuit around the field coils. A damping device consisting of a disc of conducting material is driven from the armature shaft and is acted upon by electro-magnets included in the circuit to be measured, the connection between the damping disc and the armature being rigid and non-yielding. The registering device is in positive connection with the damping device.

490,699.—*Recording Ammeter.* E. Weston.

A body of conducting material of known resistance per unit of length, is arranged in the arc of a circle and is connected in direct circuit with the current to be measured, and in a shunt circuit is contained a pivoted arm, whose end is in contact with the body of conducting material, and is adapted to move over it, together with a motor mechanism which upon a change in the strength of the current traversing it, causes the pivoted arm to change its position. The construction is such that upon a change of current strength on the direct circuit the corresponding change in voltage on the shunt circuit will cause the motor mechanism to act to move the pivoted arm, and it will continue to act to move the pivoted arm until the latter has assumed such a position with relation to the body of conducting material that the former difference of potential on the shunt circuit is reëstablished. Thus any change in the strength of the direct current causes a change in the strength of the current passing through the motor mechanism in the shunt circuit and causes the pivoted arm to move over the body of conducting material, thus placing the shunt circuit in multiple circuit with more or less of the conducting body to reduce its difference of potential. The body of conducting material over which the pivoted arm moves is graduated to indicate the strength of the current measured, while a pencil upon the end of the arm rests upon a moving sheet of paper, thus recording the number of ampères on the circuit at various times.

490,663.—*Electric Block Signal System.* J. La Burt.

One feature of the invention consists in the provision of means whereby the steam of the locomotive is automatically cut off, if for any reason, accidental or otherwise, the engineer runs past the signal when set.

491,311.—*Electrically Heated Soldering Iron.* Samuel B. Jenkins.

The mass of iron forming the soldering point is provided with parallel projections, around and about which the wires are wound and disposed in a single layer, each wire being thus brought into close contact with the material of the iron.

491,320.—*Electric Water Heater.* Willis Mitchell.

The heater is in the form of a vertical cylinder filled with water and provided with a metallic bottom, upon the under side of which are provided a number of projections wound with wires conveying electric currents. Passing through the cylinder is a coiled wire which contains the water to be heated.

490,279.—*Electric Meter.* D. Frölich.

A bar of soft iron, movable in a horizontal plane, is surrounded by two coils, one of which has a magnetizing and the other a deflecting action on the bar. Both coils are traversed by the current to be measured or by fractions thereof, while by means of suitable apparatus a change of current is effected in one of the two coils, thus causing the iron bar to partake of an oscillating motion. The motive force acting upon the bar producing the motion will be proportional to the product of the magnetism of the bar into the current flowing through the deflecting coil; if, therefore, the proportions be so taken that the magnetism of the bar is proportional to the current flowing through the magnetizing coil, the motive force will be proportional to the square of the main current, as both the magnetizing and the deflecting currents are proportional to the main current. Since the number of oscillations in a unit of time is proportional to the square root of the motive force, the number of oscillations of the iron bar will be proportional to the current to be registered. The number of oscillations of the iron bar is registered on a counter, thus indicating directly the number of ampère hours consumed in the main circuit.

490,358.—*Electrical Musical Instruments.* A. Montanelli.

The invention is designed to produce the same tones upon a number of instruments simultaneously, while but one is played manually. In operation with a mandolin and an organ or piano, the mandolin is played in the ordinary manner, and as the strings are pressed against the neck of the instrument at various points to produce the desired tones, electric circuits are completed by the strings making contact with metal plates provided upon the neck. Electro-magnets are placed in the various circuits which control keys of the secondary instrument corresponding to those played on the primary instrument. By the closing of the circuits the electro-magnets are energized to draw down the proper keys which serve to actuate the hammers of the piano or to open the air passages to the reeds of the organ.

491,346.—*Electro-Mechanical Movement.* Elisha Gray.

The invention relates to mechanism for causing a number of successive breaks in a circuit due to the winding or unwinding of a cord from a drum and is adapted to the transmission of telautographic messages. In this system of transmission a facsimile of the characters written at the transmitting station is reproduced at the receiving station. To a pen are attached cords extending at right angles to one another and passing each around a spring-pressed drum. As the pen is moved in writing the characters the drums are caused to wind or unwind a certain distance, depending upon the direction and extent of the motion imparted to the pen. The motion of the drum causes a number of successive breaks in an electric circuit extending to the receiving station, the number of breaks depending upon the extent of motion of the drum. At the receiving station is provided a second pen connected with step-by-step actuated devices which respond to each pulsation to move the receiving pen a distance corresponding to the distance the transmitting pen was moved during the time between two breaks in the circuit that produced the pulsation. By this means the movement of the transmitting pen is reproduced in the receiving pen and the characters written at the transmitting station are reproduced at the receiving station.

ALTERNATING CURRENT APPARATUS.

PART III.—BY C. KAMMEYER.—*Concluded.*

Do not neglect to examine carefully the point of connection between armature cables and terminals of fields for any loose contact or broken connection, which might cause an open circuit.

In case the exciter fields do not show any magnetism, it is evident that there is an open circuit in either the exciter fields or the armature. The fields being wound with comparatively fine wire, are apt to become injured where the wire leaves the coils and where it connects with the brushes or armature terminals. The ends of the exciter fields should always be properly fastened and supported so as to prevent any vibration or other motion of the wire. For bringing out the wire ends some makers use flexible cable, which is more or less yielding and far better than solid wire.

If there are no indications of an open circuit in the exciter fields, it is probable that the armature is at fault. While as a rule, an open circuit may be looked for in such a case, it must not be forgotten that a short circuit in the armature or field coils will have practically the same effect of preventing the exciter from furnishing current. Copper or carbon dust, if allowed to accumulate, is apt to bridge over the insulation between brush holder studs and rocker arm and thereby cause a partial short-circuit. Exposed or bare portions of either the armature cables or field wires may touch the metal frame of the machine at the same time in two or more places and thereby short-circuit the current.

Where carbon brushes are used on the commutator, it sometimes happens that the exciter will not "build up" after having been shut down for some time. This is due to the film or glaze of carbon and oil, not only on the commutator, but also on the ends of the brushes, offering too much resistance to the current. The application of fine sandpaper will effectually remedy the difficulty.

It is a good plan to periodically subject the dynamo and accessories to a thorough cleaning. With a tolerably stiff hair duster or brush, assisted by a hand bellows, loosen and remove all copper

or carbon dust as well as other dirt. Do not use any sharp or pointed instrument for this purpose, as the insulation of some wire or wires is apt to suffer thereby. If necessary, loosen all contacts, terminals, screws, and thoroughly remove all grease, oil or dirt. It will be well to properly tag or in some other way mark all parts before disconnecting them so that no mistake can occur in re-assembling them on account of a wrong connection. The writer has in mind a plant that was shut down for 24 hours, simply because the exciter armature cables were crossed, and the "electrician," as he afterward explained, did not think it made any difference, because an alternating machine "had no polarity."

The bands or binding wires of both armatures should also be examined, and if the least bit loose, must be wedged up with mica or entirely rewound. The constant expansion and contraction of an armature will sooner or later loosen the bands, and unless promptly repaired, disaster is certain to result. This also applies to all moving wires or terminals, subject to vibration or magnetic action.

Most modern machines are now supplied with self-oiling bearings. While these do not require the constant watching necessary with oil-cups, they should occasionally be examined to see that the oil rings are free to revolve and perform their functions properly, also that the oil in the reservoir is up to the proper level. Every week or two the oil chambers should be drained and fresh, clean oil supplied. The dirty oil can be filtered and used over again. Do not fill the oil reservoirs to a higher level than necessary to freely supply the oiling rings. Fully as much trouble is caused by too free a use of oil as by the want of it. Oil leaking from the oil cups or bearings to commutator, brushes or other parts must be avoided. The oil should also be prevented from being thrown into the armature or on the wires or cables in general. Nearly all oils will ruin the insulation of wires or cables. The current of alternators being generally of high voltage, the question of insulation becomes a very important one. A drop of oil, in the right spot, supplied with a liberal quantity of carbon or copper dust can bring untold mischief.

THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

The sixteenth convention of the National Electric Light Association was held in St. Louis, on February 28 and March 1 and 2.

The headquarters of the association were established in the Southern Hotel and the meetings held in the assembly room on the sixth floor of the Telephone building.

Tuesday morning at 10:30, President James I. Ayer called the meeting to order and introduced the Hon. E. A. Noonan, mayor of the city of St. Louis, who in a characteristic speech tendered the hospitality and the freedom of the city to the members and guests of the association.

President Ayer then delivered the annual address, referring to the wonderful growth of the industry since the association was founded in 1885; to the application of electricity in St. Louis, where 271 dynamos supply current to 260,000 incandescent and 5,330 arc lamps, and 660 stationary motors, utilizing 1,800 horse-power; while to operate the 160 miles of street railway, 1,126 street-car motors are in service with 8,240 horse-power in generators. In addition, 8,000 horse-power in generators and the necessary motors will be added to operate the roads now in course of construction before the year ends, making a total generating capacity exceeding 30,000 horse-power to supply the sixty square miles of territory with light and power. Referring to the lamp question, Mr. Ayer stated that the present condition of affairs called for a decided "reform in our laws that will provide adequate protection for the investor as well as the inventor; and we earnestly recommend some action on the part of this association, that our properties which have been so long regarded with distrust and suspicion by the financial world, may not have added to their burdens the question of their right to use devices which are vital to their success; and to so place the central station manager that he must not add to his other essential qualifications that of being able to divine what the courts may do in the future." Mr. Ayer touched on the formation and work of the Canadian Electrical Association; the World's Fair, and advised suitable action, stating that "too much praise cannot be awarded those who have labored

to produce this most complete exposition of the science in all its forms"; congratulated the association on its increase in membership; referred to the proper education of employés of central lighting stations and to the wage question and paid a high compliment when saying "many acts of real heroism are performed by the lineman or the dynamo tender, only that the service may not be interrupted, and that many times without a passing comment."

Mr. A. D. Adams, of Indianapolis, then read a brief and interesting paper entitled "Wrought Versus Cast Iron for Field Magnet Frames," showing the advantages to be derived from the use of wrought iron in place of cast iron for the field magnet frames of bipolar dynamos.

Various letters of invitation were then read, followed by the report of the Committee on the World's Fair, after which the meeting was adjourned.

At 2:30 P.M. President Ayer called the members to order and introduced Capt. William Brophy, who read a paper on the "Relations of Insurance to Electric Lighting and Power," in which he strongly reiterated his former advice to plan and build electrical stations with an eye to "future growth and enlargement without disturbing the existing arrangement of machinery," and warned those present against the folly of renting space in abandoned buildings, old factories and planing mills, where the fire risks were already extra hazardous. Considerable discussion followed without eliciting much information of value outside of Captain Brophy's remarks.

Judge Armstrong then read a paper prepared by Mr. R. H. Sterling, of the Consolidated Electric Company of Denver, entitled, "Some Experience with the Alternating System," and giving in detail valuable suggestions in the economical and practical operation of incandescent lighting stations. During the discussion that followed, remarks were made on the comparative economy and feasibility of the alternating and the direct current systems; the minimum first cost of incandescent lights, and the average life of a lamp on the alternating and the direct current systems. But the information obtained was quite meager.

Wednesday morning the members listened to Prof. George Forbes' remarks on the subject of "Thermal Storage for Central Stations," which excited much interest, and awakened important

discussion that was participated in by Dr. Bell, T. Carpenter Smith, W. J. Hammer, Charles Wirt and others, and incidentally some data regarding storage batteries was given out.

Wednesday afternoon's session was opened by the reading of a paper entitled "Long Distance Transmission of Power," by Mr. Charles S. Bradley, followed by a paper entitled "Under What Conditions is the Use of Water Power Economical?" by L. S. Stillwell, after which Dr. Bell read a paper on "Power Transmission for Central Stations." As the three papers practically covered the entire subject of power transmission the readers secured attentive listeners. The discussion was opened by President Ayer, followed by W. J. Hammer, A. D. Adams, Professor Weston, Professor Forbes, and others.

Wednesday evening the members gathered with 5,000 citizens in the Grand Music Hall of the Exposition building and witnessed the marvelous and brilliant demonstrations with high frequency currents that have won the admiration of the more prominent electricians in Europe as well as in this country, and made famous the name of Nikola Tesla, the quiet, unassuming Hungarian who has captivated the scientific world. After the lecture an opportunity was afforded many to momentarily meet Mr. Tesla.

Thursday morning's session was opened with the reading of an important paper on "Underground Conduits and Conductors," prepared by Mr. W. H. Browne, general manager of the United Electric Light and Power Company, of New York city. Mr. Browne enumerated the mistakes made in placing the wires underground in New York, and gave suggestions that must prove of value to companies who contemplate placing their wires underground. On opening the discussion, Mr. Ayer remarked that the valuable data presented would go far toward solving the vexed problem of underground versus overhead construction. Mr. J. J. Moore, of New York city, added some interesting testimony and stated that while the condition of affairs in New York was vastly different from the conditions met in other cities, yet he thought every company should go underground in thickly settled districts as rapidly as possible. Mr. De Camp astonished the members by remarking that municipalities should build and own the conduits, and Mr. Francisco appeared to coincide in that view of the question.

Mr. Calvert Townley, of the Westinghouse interests, then read

a paper entitled "The Incandescent Lamp from a Commercial Standpoint," containing much data of interest even though presented in a form more suitable for an Institute meeting. After the reading of the paper the meeting adjourned till 2 P.M.

The afternoon session opened with the reading of an instructive paper by Mr. H. C. Meyer, on the "Preservation of Poles and Cross Arms," replete with interesting data. Judge E. A. Armstrong then read a characteristic paper on the "Morals of Corporations," advising united rather than individual effort in attempting to attain desired objects. The discussion of Mr. Townley's paper being opened, Prof. Edward Weston made some very pertinent and instructive remarks regarding the various forms of carbons used in incandescent lamps, their treatment, life, etc., all of which was received with the closest attention. Mr. T. Carpenter Smith followed by charging the General Electric Company with a lack of business tact in not permitting purchasers to buy any lamp desired, irrespective of price. In other words, he thought the lamp manufacturers should be permitted to continue the manufacture of lamps on the payment of a royalty. Doctor Bell here stuck a pin through some "fake advertising" in a local paper, and the discussion becoming rather personal, Mr. De Camp moved that the subject be referred to the proper committee. The meeting was then adjourned, and the members watched the passing of Mr. Ayer's wheeled equipment consisting of 100 vehicles.

A few moments later the active members of the Association met in executive session, and after transacting routine business elected the following officers for the ensuing year: President, Hon. E. A. Armstrong; first vice-president, M. J. Francisco; second vice-president, C. H. Wilmerding; secretary, George F. Porter. Executive Committee — John A. Seely, E. F. Peck, A. J. De Camp, W. J. Morrison, Harrison J. Smith, G. H. Blaxter, Frederic Nichols, A. M. Young, H. H. Fairbanks.

This convention is considered the most successful in the history of the association, and Mr. Ayer may well congratulate himself on the large attendance, especially of eastern members; and the unusual number of central station men present, there being no less than eighty. In presiding over the meetings, Mr. Ayer displayed excellent tact and discreetly led the discussion away from dangerous shoals, and by his untiring zeal and earnest desire to advance the personal comfort of every guest, well merited the

resolutions offered by Judge Armstrong, and which were unanimously indorsed by a rising vote.

Resolved, That we extend, as an association and individually, our thanks to our esteemed president, James I. Ayer, for the ability and courtesy with which he has discharged the responsible official duties of his position. As individuals we want to put on record the fact that from our experiences here in St. Louis at this convention we have learned that this affability is perfectly generated, is of the highest efficiency, the lines are innumerable, and all are underground, and sent out without a flash or drop; and on these lines there is no switch, throw-out, cut-off or arrester, and against its power no amount of trouble has been able to act as an insulator.

Entering St. Louis an utter stranger but three years ago, and then looked upon somewhat in the light of an interloper owing to his connection with the syndicate that had upset the well-laid plans of others, Mr. Ayer demonstrated in one short year his ability to plan and to execute, to construct and to operate on a scale greater than had ever before been attempted in the field of electric lighting. The high estimation in which he is now held by the citizens of St. Louis can easily be inferred from the willing efforts put forth to assist in entertaining the distinguished visitors.

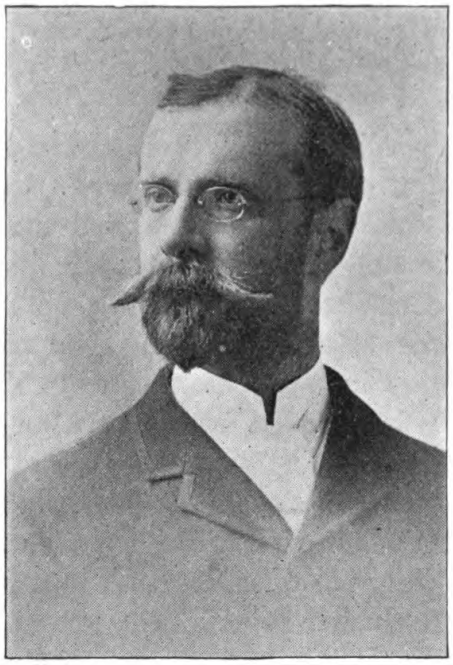
True western hospitality was typified in the cordial welcome extended by Mrs. Ayer and the other ladies of St. Louis to the members of the fair sex accompanying the delegates, and in the receptions, the carriage rides, and the theater parties that left no idle moment. And the weather was all that the ladies could desire.

Worthy of note was the presentation to Mr. C. O. Baker, Jr., of the elegant punch bowl from the passengers on the electric limited; the open house kept by the Electric Club, wherein dainty meals were served at all hours; the evening ride to the lighting and railway stations; the complimentary admissions to all delegates tendered by the principal theaters, and the afternoon drive to the suburbs followed by the banquet tendered by the Jockey Club.

A suggestion of value made by one of the members was that the papers to be read at the next meeting be previously printed and distributed in the same manner as the papers read before the American Institute of Electrical Engineers. F. DE L.

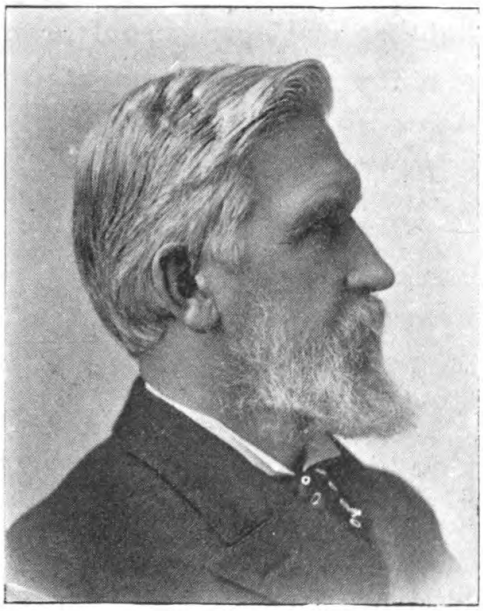
MR. R. H. PIERCE.

On Monday, March 6, Mr. Frederick Sargent tendered his resignation of the office of chief mechanical and electrical engineer of the Exposition, which being accepted, Mr. R. H. Pierce was promoted to fill the vacancy. For more than a year Mr. Pierce has acceptably filled the position of first assistant electrical engineer, winning the esteem of his superiors in authority by the zeal and energy displayed in all the work that devolved upon him. Thoroughly acquainted with the needs of the Exposition work, familiar with every plan and detail of his department, with a wide experience in engineering gained through his previous connections with the Edison and other interests, quick to grasp the situation and utilize the best material at hand, and with a happy, genial temperament that admits no obstacles too great to surmount, Mr. Pierce enters his new office with the best wishes of all his friends and the loyal allegiance of Mr. Sargent's very efficient staff.



Mr. Sargent's resignation is not surprising in view of his repeated statements that unless the contractors engaged on the work in Machinery hall were compelled to move more rapidly the power plant would not be in operation when the gates were opened. Exhausting all his own resources in hastening the work of others and receiving but slight support from those in authority, he concluded to resign. It is understood that Mr. Sargent's services as consulting engineer have already been secured for what will be one of the largest Edison stations in the country, which is a sufficient indorsement of his capacity and efficiency as an engineer.

World's Fair Electrical Engineering



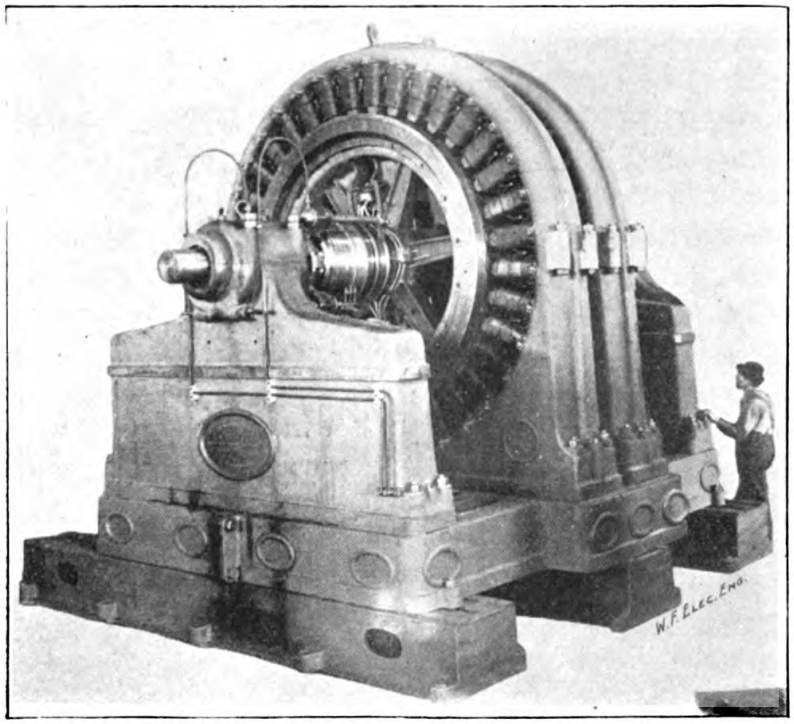
DR. ELISHA GRAY,

Chairman World's Congress of Electricians.

THE INCANDESCENT ILLUMINATION AT THE WORLD'S FAIR.

BY R. H. PIERCE, CHIEF ELECTRICAL ENGINEER.

It is not the purpose of this brief article to enter into the considerations, financial and otherwise, which led to the adoption of the system of incandescent lighting which is to be used for illuminating the grounds and buildings at Jackson Park ; nor to describe in detail the various advantages of the system as planned and installed ; but to give the reader an idea of the scope and purpose of the lighting and the general arrangement of the system.



10,000-LIGHT WESTINGHOUSE ALTERNATOR.

As the visitor enters Machinery hall by the central entrance upon the north side, he will see before him, at the end of the main aisle and in the center of the power plant, an immense engine belted to two equally immense dynamos. The engine, a

quadruple expansion Corliss, drives direct two 10,000-light Westinghouse alternators from one main 30-foot driving pulley. Two 72-inch belts, one over the other, transmit the power to the 9-foot pulleys of the dynamos. Although this engine will not be so conspicuous as to dwarf the surrounding machines, it is, in reality, capable of developing 2,500 horse-power, while the big engine at the Centennial was only rated at 1,500 horse-power. In adjoining blocks are ten 10,000-light alternating current machines driven by ten 1,000 horse-power engines, while two 4,000-light alternators and the necessary exciters are driven by engines of lesser capacity.

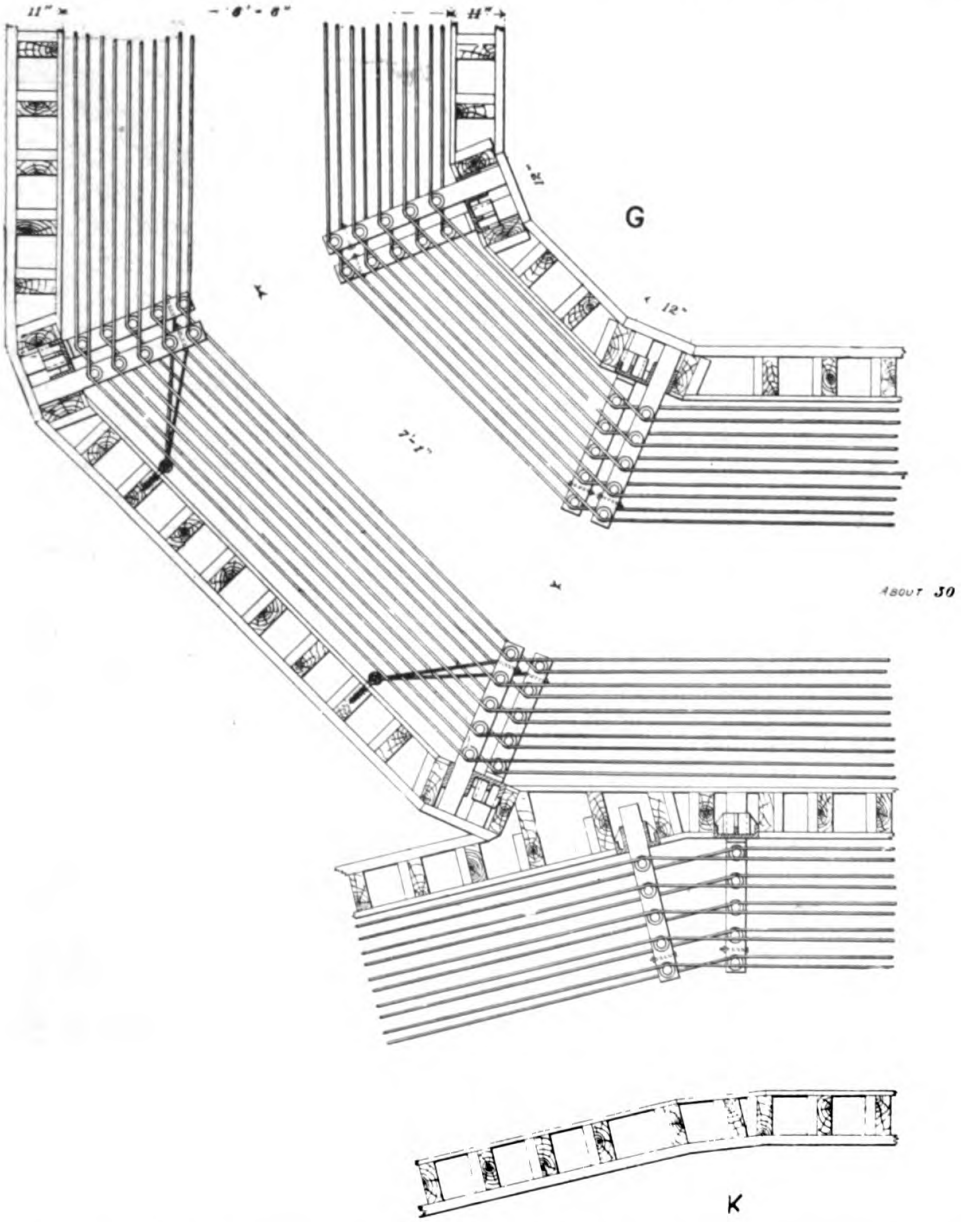
The twelve 10,000-light machines are all of the same pattern and furnish a current of 2,000 volts which is reduced to 100 volts at the transformers. Each machine carries two 5,000-light armatures upon the same shaft and can be operated as two independent machines, and though rated at 10,000 lights each, these machines have shown after careful testing to possess a capacity of 15,000 lights each of 16 candle-power. Thus the total capacity of these fourteen Westinghouse machines aggregates 158,000 16-candle-power lamps!

This division into blocks and the placing of the machines forms an arrangement which is most admirable, both for convenient operation and for showing both engines and dynamos to the best advantage, and are fully described and illustrated in the January and February numbers of this magazine.

On the south wall of Machinery hall, facing the big Corliss engine, a two-storied switch board, constructed of white marble panels set in an iron framework 76 feet long, has been placed. This switch board controls all the lights fed from the ten 10,000-light and the two 4,000-light alternators. The board is so arranged that any one of the forty-eight feeders can, at any time, be thrown on or off any of the fourteen dynamos, and with its many highly polished switches, instruments and controlling devices forms a most attractive and interesting exhibit of what is newest and best in central-station engineering. To this switch board are brought the leads from all the dynamos and exciters, the wires being carried from the machines under the floor upon the basement ceiling. The conductors, which are of lead-covered duplex Waring cable, are carried upon iron brackets of special design, and having insulating fiber bushings. From the switch

board the feeders, which are also duplex Waring cable, are carried down to the basement where they are carried across the power plant underground, in vitrified tile duct, into a fireproof room in the basement, in which are placed the lightning arresters for each feeder. Thence the feeders enter the Machinery hall subway. This subway, which is shut off from the main basement of Machinery hall by a fire wall, is 8 feet 4 inches in height and 15 feet 8 inches in width, extends under the aisle north of the power plant the entire length of the plant. It contains four series of iron uprights carrying oak cross-arms, and forms a regular pole line construction, with enough insulators in Machinery hall for carrying 276 wires, allowing but one wire to an insulator. The feeders are carried along this subway, east and west. On the east this subway joins the main subway, which was described in the January number of this magazine. In the main subway the conductors are of rubber-covered wire (Grimshaw), and are carried upon glass petticoat insulators. The subway leads direct to Mines, Electricity, Manufactures, Government and Fisheries buildings. From the main subway the circuits are led in ducts to the flower beds, the grand basin, to Administration building and to all the other buildings upon the east side of the Park which are not reached directly by the main subway. The conductors drawn into the ducts are, in all cases, lead-covered duplex cables. The ducts are of wooden "pump log," having a bore of 2¼ inches, one duplex cable being run to a duct upon the original installation, thus leaving provision for running additional feeders and of strengthening existing feeders should it prove desirable or necessary in the future. The ducts are interrupted by numerous manhole boxes of wood, having cast-iron covers, and terminate in converter pits located immediately outside the various buildings. These pits are of wood, with fire and water proof linings, and are set so as to extend but ten inches above finished grade. The size of the pits is varied according to the number of converters it is to contain, the converters in nearly all cases having a capacity of two hundred lights each. The converter pits have covers which are so arranged as to keep out all water, and, at the same time, admit of sufficient ventilation to prevent undue heating of converters. These covers can be readily lifted, so that the cut-outs and converters can at any time be inspected, and, if necessary, can be removed or replaced.

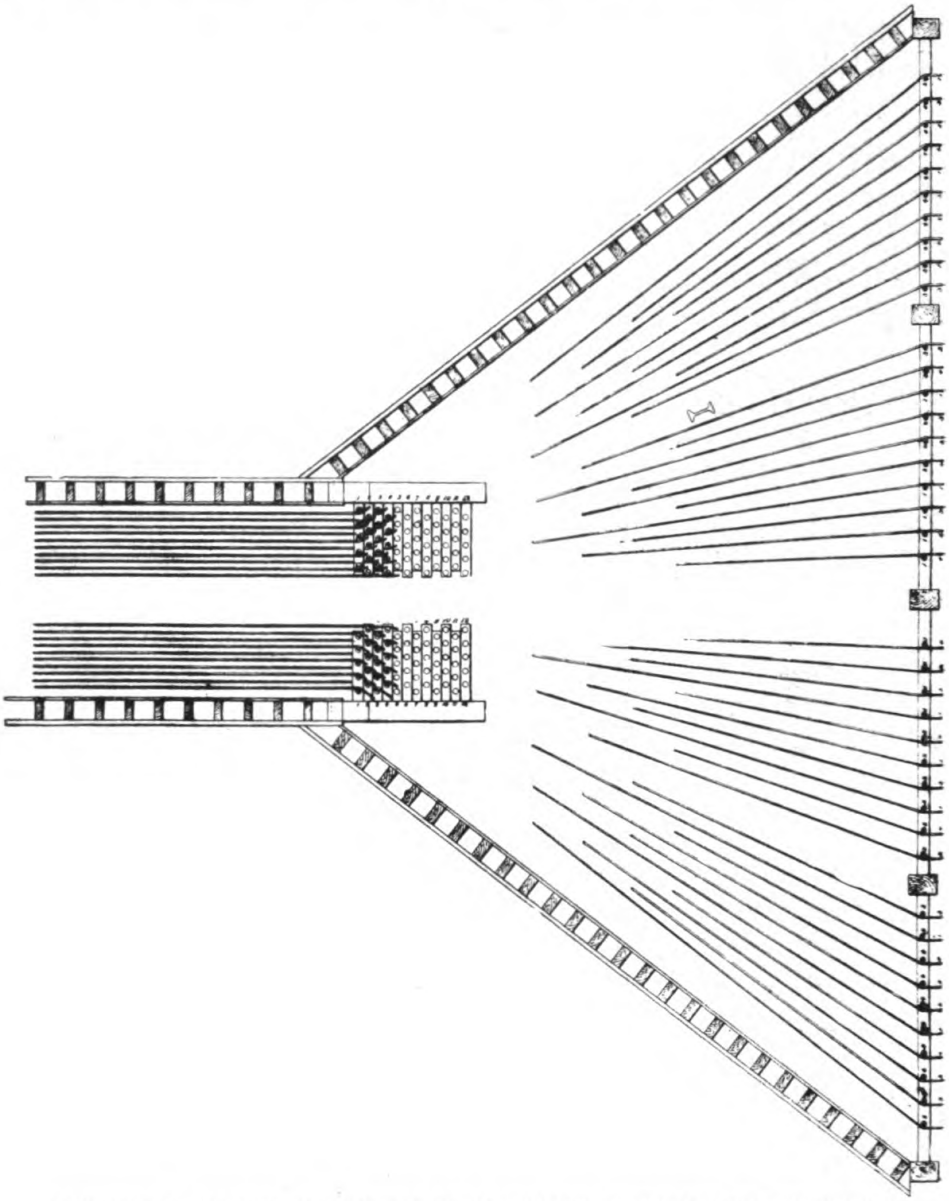
From the converter pits, the secondary circuits are led from each converter directly into the buildings through vitrified tile ducts. The circuits running west in the subway under Machinery



SECTION OF PLAN OF SUBWAY, "K" EXTENDING TO THE ELECTRICITY BUILDING, AND "G" TO THE BRIDGE.

hall leave the end of this subway under Machinery annex, and are carried in vitrified tile duct under one of the main aisles to a large manhole box just outside the north wall of the annex.

They are then carried in wooden ducts to a point near the southwest corner of Transportation annex, where they follow the line of the west fence to the northern part of the Park. This "trunk duct line" on the west corresponds to the main subway on the



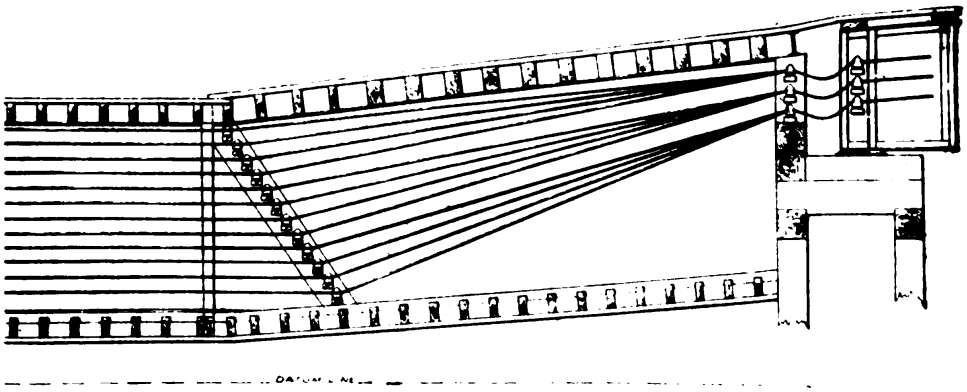
CONDUCTORS PASSING FROM SUBWAY TO SUPPORTS UNDERNEATH THE BRIDGE, Crossing the canal from Electricity building to Manufactures building.

east, and, from it wooden ducts branch out to converter pits for various buildings. One main branch leads out to the west and follows both sides of the main street the entire length of the

Midway Plaisance. The same system of manholes and converter pits prevails as on the east of the Park.

Leading north from the main subway on the east and the "duct trunk line" on the west, a system of wooden ducts runs to the Fine Arts building and, ramifying in all directions, carries conductors to all the buildings of states and foreign governments.

The main trunk line alone comprises over 76,000 feet of duct, and in the whole duct system over 225,000 feet of duct have already been laid. The main subway contains about twenty-five miles of feeders and the ducts carry over forty miles of duplex cable. The construction within the buildings varies with the design and purpose of the building, but, in all cases, the installation has been done according to the letter and spirit of the



CONDUCTORS PASSING FROM BRIDGE SUPPORTS TO CROSSARMS IN SUBWAY.

"national code," all conductors being placed so as to be *accessible*. The risers and mains have for the most part been run on insulators, and, in all inside wiring, the wires have been either run on glass knobs or in molding or interior conduit. All wire in buildings is of a high grade of rubber-covered wire, Grimshaw white core being used in all the main Exposition buildings.

The contract with the Westinghouse Electric & Manufacturing Company for incandescent lighting called for the furnishing of dynamo, feeder and converter capacity for 83,410 lamps of 16 candle-power, and 6,212 lamps of 10 candle-power, or a total of 89,622 lamps; and inside wiring, or wiring to lamps for 50,410 lamps of 16 candle-power and 6,212 lamps of 10 candle-power, or

a total of 55,622 lamps. Following was the estimated distribution of lighting:

Fine Arts' building and annexes	16,242	
Woman's building	3,000	
Administration building	5,000	
Music hall, peristyle and casino	4,368	
Total in buildings to be lighted wholly with incandescent light		28,610
Horticultural	800	
Transportation	2,500	
Mines and mining	3,000	
Machinery and annex	1,000	
Agriculture	4,000	
Manufactures	10,000	
Fisheries	500	
Total for use in main exhibit buildings		21,800
Decorative lights in flower beds and about grand basin		6,212
Total lights to be wired		56,622

Additional capacity of dynamos, primaries and converters for:

Service building	1,500	lights.
United States Government building	5,000	"
Buildings of states and foreign governments, and buildings on Midway Plaisance	26,500	"
Total	33,000	"

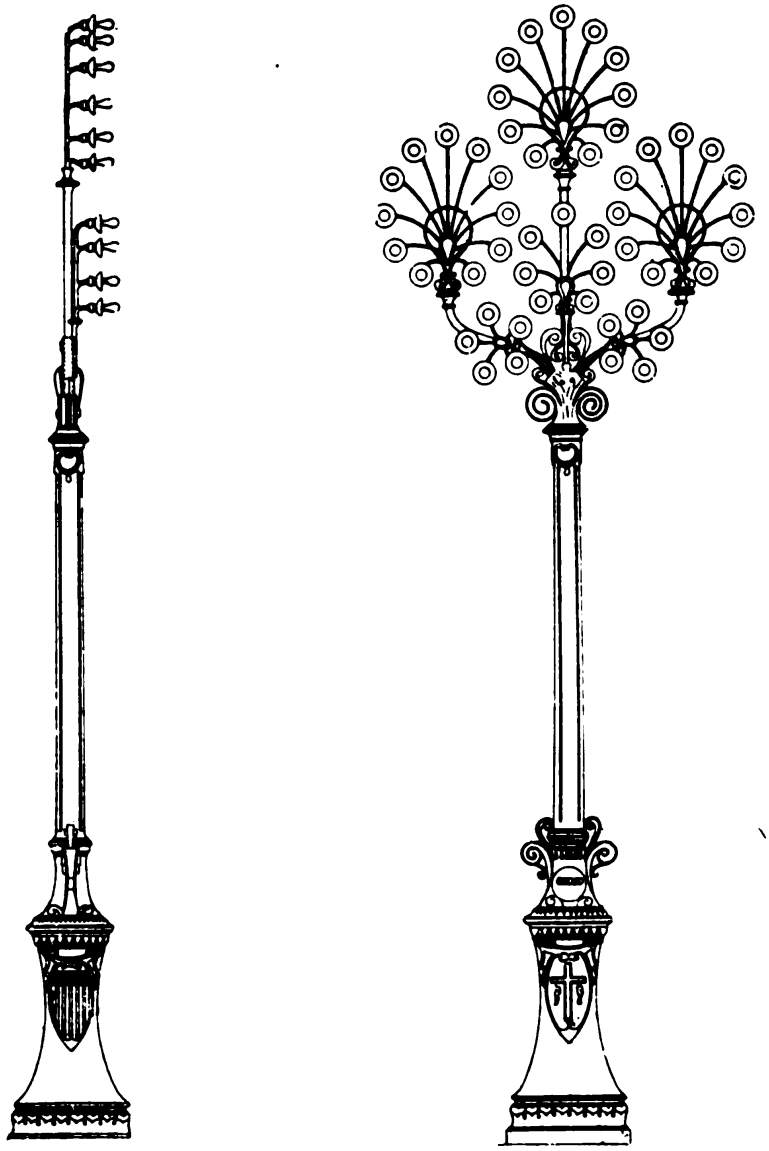
The distribution of these incandescent lights according to their application is as follows:

(1) For use inside buildings lighted wholly with incandescent light	25,918	lights.
(2) Decorative lights on exterior of buildings	5,442	"
(3) Decorative lights on grounds	6,212	"
(4) Lights in main Exposition buildings for offices, etc., and for use of concessionaires and exhibitors	19,050	"
Total	56,622	"

Of these the lights in buildings to be wholly lighted have been placed substantially as originally laid out.

The decorative lights have been placed as laid out with the exception of but few changes. Since the original estimates were made many new buildings have sprung into existence, and many of the lights for use in main Exposition buildings have been placed for use of the Exposition, but it will be possible with the system of feeders as at present installed, to meet the demand for

all incandescent lights that may be desired by exhibitors or concessionaires. The decorative lighting is limited to the outlining of the main lines about the Grand Basin. First, the shore line of the basin is outlined by a row of lights; next, the border of the flower beds is outlined in light; then the main cornice line of the



FIFTY-LIGHT CANDELABRA IN ADMINISTRATION BUILDING.

buildings, extending completely around the Grand Basin at a uniform height of about sixty feet, will be marked by a row of lights; and, finally, the Administration building will be outlined

in light, each horizontal line of the architecture, the ribs of the great dome and above all the corona, will be shown in dotted lines of light. Aside from this lighting, the use of incandescent light on exteriors has been confined to the lighting of the Wooded Island and the use of lights here and there to produce a soft glow in colonnades and loggias, and serving, not to attract attention to designs in light, but to bring out to the fullest extent the architectural beauties of the buildings.

The two problems of lighting, by far the most difficult presented, have been the lighting of the Art Galleries, with the two miles of reflecting screens, and the lighting of the dome of the Administration building, which is larger by far than the dome of the Capitol of Washington or the Dome Central at Paris. The lighting of this dome in particular is to be unique, and cannot fail to be effective. On the floor of the dome, which is octagonal, there will stand in the eight angles eight great spreading candelabra of special and beautiful design, each bearing fifty 16 candle-power lamps. High up, at the spring of the interior dome is a gallery running clear around the dome. The gallery has a metal railing, and upon this railing will stand fifty-six 7-light standards, forming a grand corona of light 120 feet in diameter. Far up above and through the opening in the top of the false dome will be seen the beautiful painting upon the ceiling of the outer dome, as it is illuminated by a circle of arc lights which are themselves hidden from view between the two domes. For this arrangement of light, the Exposition is indebted to Mr. Luther Stieringer, who has devoted himself to the study of the lighting problems at Jackson Park, and whose judgment, acquired by a lifetime of unusual experience, has always aided in their solution.

An effective piece of lighting will be seen in the Fisheries building. The large circular pavilion upon the east will be used as an aquarium. Around the building are arranged continuous concentric rows of great tanks. The sides of these tanks are of clear glass and are continued to the ceiling by stained glass screens, so that the observer walks in a covered corridor the sides of which are of glass, and through which can be seen the representatives of all the finny tribes disporting themselves in their native element. At night no lights will be visible, but the tanks will be lighted by hundreds of incandescent lamps placed under screens above the tanks, so that the light does not strike the eye, but is

diffused throughout the water, lighting it up as effectively as daylight.

The Terminal station, Festival hall and Wooded Island will be lighted from a separate machine located in the German exhibit space in Machinery hall. This plant, which is to be installed and operated by the Siemens & Halske Company, of Berlin, will be of interest to electricians as it will comprise arc lamps of three, six and nine ampères, as well as about two thousand incandescent lamps, all operated from one generator, and the incandescent wiring will be installed upon the five-wire system with equalizers at the centers of distribution, thus forming a working exhibit of a station practice not before seen in this country. The Wooded Island will be lighted with 25 candle-power incandescent lights placed in large closed shades upon short ornamental posts, and the soft lighting of the many lamps among the trees and shrubbery will form a pleasing contrast to the intense light of the arc lamps about the main buildings.

Many problems have presented themselves to the designers and builders of this plant, but the continued aim of all concerned has been that it should have above all the two great requisites of an ideal station — safety and reliability.

GENERAL WORLD'S FAIR NOTES.

THE final programme of ceremonies for opening the Fair on May 1 is as follows:

Music—Columbian march and hymn, John K. Paine.

Prayer.

Presentation of chiefs of departments and foreign commissioners by the director-general.

Music—"In Praise of God," Beethoven.

Address and opening of the World's Columbian Exposition by the President of the United States.

Starting of machinery, during which time will be performed "Hallelujah Chorus," Handel.

Official visit from the President of the United States and the officials of the World's Columbian Commission to the various departments, arrangements having been made previously with each chief to receive them.

But two speeches will be made, one by Director-General Davis, the other by President Cleveland. Both will be brief. The entire programme will scarcely require more than an hour.

The sentiment is growing in the ceremonies committee that the exercises should be held out of doors. The plaza in front of Government building seems to be the favored location, as more people could get together there than at any other point on the grounds, and that location will probably be selected.

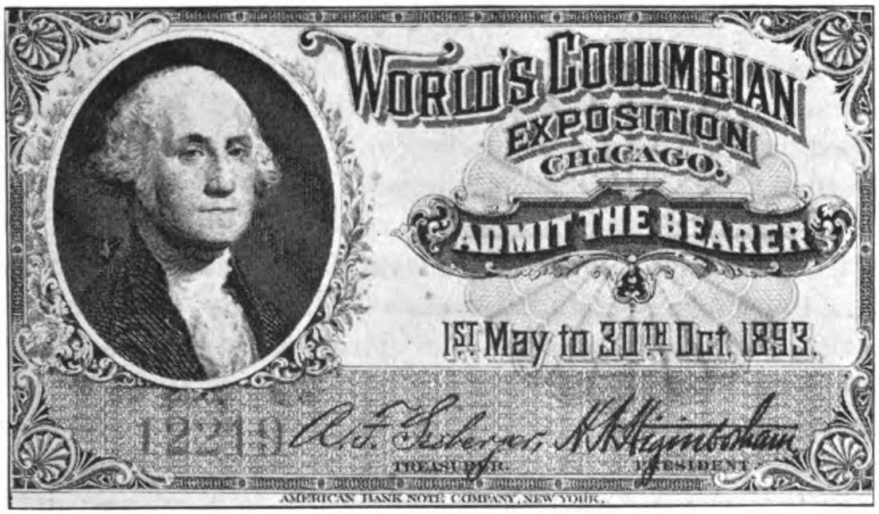
LESS than a month remains in which to complete the grand work at Jackson Park, to place the exhibits and put the finishing touches on grounds and buildings, and have everything in readiness when the gates are formally swung open on May day. This opening day falls on Monday, and there is every probability that on the day preceding the opening ten thousand petitions for the success of this great educational undertaking will ascend from the altars of the world.

Director-General Davis has again declared that April 15 is positively the last day on which exhibits will be received, and that exhibitors must have their display on the grounds on that date or lose their space.

Thus only on the exhibitors will fall the blame of not having

their section in readiness when the opening day arrives, as every precaution has been taken to receive and place the exhibits on arrival.

ADMISSION PASSES AND TICKETS.—Season passes are now being delivered to exhibitors and employés as rapidly as the photographs of the holders can be finished and attached. Sixty thousand books will probably be required, and each book is placed in a neat leather pocket case when delivered. In addition to these season passes it is expected that 10,000 thirty-day coupons will be issued and many ten-day coupons.



ONE OF THE SOUVENIR TICKETS.

The souvenir tickets for general admission are selling rapidly, more than 100,000 having already been purchased at 50 cents each. As there are four in this series of tickets, printed on heavy cardboard, resembling in general design the fractional currency of bygone days, with portraits of Washington, Lincoln, Columbus and the head of an Indian, respectively, it is expected that many will be retained as souvenirs.

There will be no commutation tickets. Every person over six years of age not entitled to a pass will pay the admission fee of 50 cents. Children under six years of age will be admitted free. A commutation book selling at $50 was contemplated, but later the idea was abandoned.

Stockholders will enjoy no greater privileges in the matter of

admissions than outsiders. The only exception to this rule is that two tickets have been given to each stockholder for each share paid in full prior to September 1, 1891, and one ticket each to stockholders paying in full prior to July 1, 1892.

To facilitate the rapid handling of the throngs that will desire entrance, thirty-two special ticket agents have been assigned to twenty-two different offices, ten of which are at the stations of the Illinois Central Railway, six at the Van Buren street pier, and one each in six of the prominent down-town hotels.

At the grounds there will be 326 turnstiles, 182 ticket windows, 172 exit gates, and 97 ticket booths. It is estimated that 2,000 people can pass through each turnstile in an hour. It hardly seems possible. But if only 300 pass through each of 100 turnstiles each hour, there should be little delay in securing admittance. As the visitor reaches the turnstile the ticket is dropped into a receiving box wherein it is automatically chopped or mutilated by the turning of the stile.

THE grand railway passenger station that faces the Administration building is practically completed and the train sheds are receiving their last coat of paint. Thirty-five tracks, 850 feet in length, enter under these sheds, namely, nine sets of two tracks and a switch track each, and four sets of two tracks each, without a switch track. The switch track is placed between its two respective tracks and enables the locomotive to be moved quickly from the front to the rear of its train while the passengers are leaving the cars and then to withdraw the train from the sheds without the loss of time that would result in backing out. There is ample room for thirty-five distinct trains of thirteen cars each holding sixty or more passengers each, with locomotives attached, to stand side by side. This affords a capacity of 27,000. Then there is a storage yard holding twenty trains of equal length that can be moved in as soon as a like number are loaded and sent out. Thus if desired over 40,000 passengers can be started homeward every thirty minutes or less. Between each set of tracks a strong fence has been erected having turnstile gates and the visitor is not supposed to have entered the grounds till he has dropped his ticket in the slot and passed through one of these gates.

Nearly opposite Sixty-sixth street the signal tower is located from which the movements of all trains are governed. When a

train is ready to start an electric signal notifies the train director in the tower, who notes the track on which the train stands from the automatic record, throws the levers controlling the proper switches, and by means of a second lever signals the engineer to move out; and the same system applies to incoming trains. This tower is an ordinary frame building, but in the upper story, lighted by thirty windows that afford a view in every direction, is one of the most wonderful banks of interlocking switch machinery in the world, a network of tubes and bars sixty-seven feet long and twenty-four feet high, the system requiring 400,000 feet of pipe in its operations.

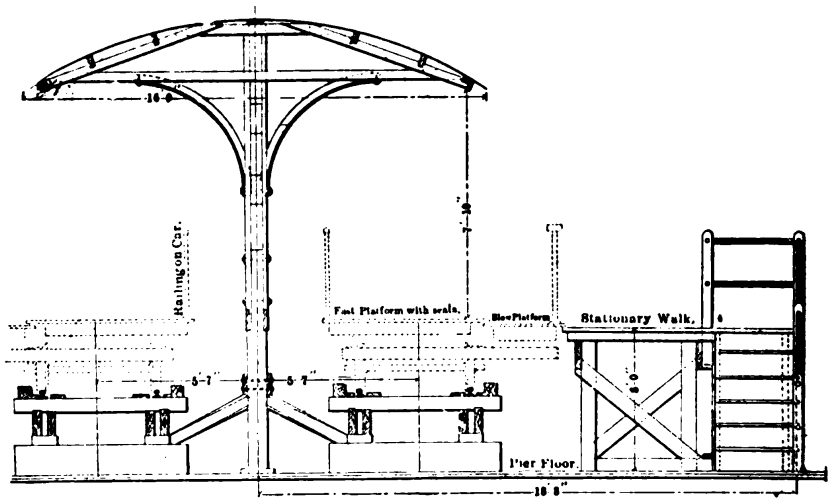
There are forty-two signal levers, seventy switch levers and thirty-eight detector bars and bolt lock movements. The latter forms an ingenious device for the prevention of derailing. Every time a switch is thrown a detector bar lever is also worked. This makes sure that no switch underneath a train can be thrown while the train is in motion. When both the switch and detector bar levers have been worked the signal is thrown. The forty-two signal levers operate seventy-seven signals in the yards, of which sixty-seven are dwarf signals and ten "route" signals. The seventy switch levers operate ninety-one separate switch movements. The thirty-eight detector bar levers operate as many bolt locks.

In the lower tower, at Sixty-ninth street, the same principle of lever bank and pipes is used, only the bank is smaller. In the lower tower there are seventy levers, of which fifty-four are active and the balance held in reserve.

This interlocking switch apparatus is constructed by the Wuerpel Switch and Signal Company, of East St. Louis, and was secured by the Exposition Company on specially favorable terms. It is intended as a model exhibit, and was furnished to the Exposition for about $25,000.

PROJECTING out from the Casino extends a wide pier to a distance of 2,310 feet, forming one of the longest piers in the world. It is 250 feet in width, has an area exceeding thirteen acres and contains 8,000 piles about thirty-five feet in length and driven to an average depth of 12 feet, 3,000 feet of lumber, 5,500 cords of stone and 151 tons of iron. At this pier the great majority of lake craft will land their passengers, many of whom

will then ride to the Casino on the movable sidewalk that occupies the center of the pier. This movable sidewalk rises five feet above the floor of the pier, and consists of a fast-moving and a slow-moving platform supported on ten iron motor cars and 341 wooden cars rolling on tracks two feet ten inches above the pier level. The seating capacity of the line is claimed to be nearly six thousand, while it is expected that four or five times that number of passengers will be carried each hour. The total length of the level line is 4,300 feet, 963 of which are taken up by the two loops. As only that portion of the pier occupied by this movable sidewalk is covered, it is assumed that the majority of the visitors



ELEVATION OF MOVABLE SIDEWALK.

arriving at the pier will avoid the long walk by riding, as over the entire length extends a permanent umbrella shed roof. The sidewalk is reached by passing through any one of seventy-five turnstiles and up a low stairway to the stationary platform, from whence the visitor steps onto the slow-moving platform, and if desiring a seat, passes to the swiftly moving section. The necessary motive power is furnished by twenty motors of 15 horse-power, each mounted in pairs on standard trucks on the ten motor cars, and current supplied thereto by under running trolleys, wiring and trolleys being placed out of sight beneath the platform. While the platform is supposed to be constantly in motion, it can be stopped almost instantly at any point. A fare of 5 cents or 10 cents, depending on the trip, may be charged.

IN addition to the facilities afforded by the steam railway lines entering the grounds, visitors also will be carried to the gates by electric, cable and horse railway lines, by lake craft and by the Illinois Central suburban line. The capacity of these lines has been estimated on a conservative basis to exceed 110,000 an hour, and in President Higinbotham's annual report he tabulated these estimates as follows:

"Chicago City Railway, Cottage Grove line	20,000
Chicago City Railway, State street and Sixty-third street lines	20,000
Illinois Central Railroad, on existing tracks	21,600
Illinois Central Railroad, on additional through tracks	14,400
Water transportation between the lake front and Jackson Park	10,000
Water transportation between points on the North side and Jackson Park	5,000
Alley Elevated line	20,000
Making a total each hour of	110,000

"It is estimated that fully 25,000 people will reach the grounds on foot and in vehicles by means of the subways under the tracks of the Illinois Central railroad, thus making the total 135,000 an hour. This total can be maintained for from three to four hours in the morning and for the same time in the evening, by which it is apparent that 300,000 can be carried to the Park in the morning in a little over two hours and returned in the evening in the same space of time. Thus a problem of pressing importance, the equal of any affecting the success of the Exposition, was adjusted and placed safely upon the road to satisfactory solution."

ONCE within the gates the visitor may wander whither he pleases without extra charge, though many statements to the contrary have been circulated. And it was to correct the false impression created by these stories that President Higinbotham issued the following circular over his signature:

WORLD'S COLUMBIAN EXPOSITION, CHICAGO, March 30, 1893.—To the Public: Because of many misrepresentations and misstatements relative to Exposition management and affairs being in circulation through the press and otherwise, both in this country and abroad, and in reply to many letters of inquiry or complaint touching the same matters, it seems advisable that some official statement regarding them should be made to the public. Therefore I respectfully ask that the widest publicity be given to the following facts:

1. The Exposition will be opened in readiness for visitors May 1.

2. An abundance of drinking water, the best supplied to any great city in the world, will be provided free to all. The report that a charge would

be made for drinking water probably arose from the fact that Hygeia water can also be had by those who may desire it at 1 cent a glass.

3. Ample provisions for seating will be made without charge.

4. About 1,500 toilet rooms and closets will be located at convenient points in the buildings and about the grounds and they will be absolutely free to the public. This is as large a number in proportion to the estimated attendance as has ever been provided in any exposition. In addition to these there will also be nearly an equal number of lavatories and toilet rooms of a costly and handsome character as exhibits, for the use of which a charge of 5 cents will be made.

5. The admission fee of 50 cents will entitle the visitor to see and enter all the Exposition buildings, inspect the exhibits, and, in short, to see everything within the Exposition grounds, except the Esquimau village and the reproduction of the Colorado cliff dwellings. For these as well as the special attractions on Midway Plaisance a small fee will be charged.

6. Imposition or extortion of any description will not be tolerated.

7. Free medical and emergency hospital service is provided on the grounds by the Exposition management.

8. The Bureau of Public Comfort will provide commodious free waiting-rooms, including spacious ladies' parlor and toilet rooms in various parts of the grounds.

H. N. HIGINBOTHAM, President.

FROM an artistic point of view it is gratifying to learn that all the color schemes for decorating the World's Fair buildings were rejected and with one exception a soft creamy white is the prevailing color at Jackson Park; not the painful, glaring white, but a white of mellow tone, relieved of all suspicion of monotony by the rich coloring within the arcades, the wealth of multi-colored banners, and the shifting throngs of visitors; a color in keeping with the dignity and the splendor of all that has there been achieved.

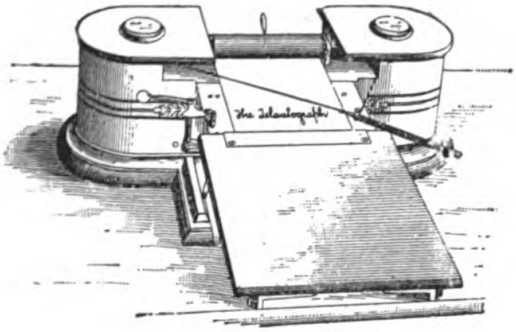
The one exception is the Transportation building, the exterior of which has been decorated with intricate designs in colors, some thirty different colors or shades being used, presenting a gorgeous appearance, that, taken with the magnificent entrance, will capture the visitor from the more southern latitudes where richness and variety of colors often run riot. The "Golden Gate" forms the east entrance to the building, and in keeping with the type of architecture it represents, is ornamented after the fashion of ar entrance to a Moorish palace of gold, each of the four recessed arches being treated with a different shade of gold, while the figures on the palladium representing "The Genii of Transportation," which fills the arched space directly above the entrance.

and also those on the panels, are picked out in different colors to represent metals. The central figure on the palladium is a youth, his feet resting on a globe, typifying the earth as it floats through ether. On each side are two horses, grand in action, and a figure lifting a shell from the sea, embodying the ocean commerce. Other figures represent velocity and plenty.

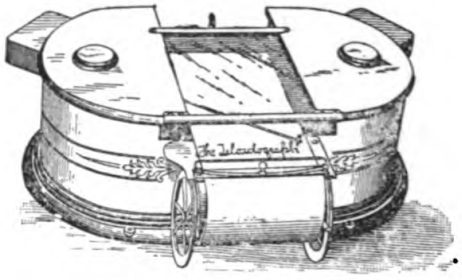
Machinery hall is treated with the creamy white in keeping with the general plan, but the panels under the arches are lightly tinted to an old ivory color, adding depth and warmth to the shadows, and the conspicuous corners, caps of columns and projecting stucco work are touched with gold leaf.

IN THE ELECTRICITY BUILDING.

An exhibit that will prove attractive to members of the press, to stock brokers and commission men, train dispatchers and all who have frequent recourse each day to instantaneous communication, is the Gray telautograph, by means of which a personal message is duplicated at a distant point exactly as sent by the writer. Moreover this feature of accuracy is secured without the assistance of trained operators, as, after a moment's explanation, anyone of ordinary intelligence can handle the pen the tracings from which reappear at the other end of the line.



THE TRANSMITTER.



THE RECEIVER.

Briefly, the telautograph consists of two instruments known as the transmitter and the sender, each contained within a compact and neatly constructed case less in size than a typewriter case, the two instruments standing side by side on the desk. To the special pencil held by the sender of a message two fine cords are attached, and each stroke made with the pencil actuates these cords which in turn act on the mechanism of the drums around which the cord is wound, and by a series of mechanical and electrical impulses these motions are reproduced on the receiver, where two aluminum arms, one of which holds a minute glass tube through which the ink flows by capillary attraction, traces the writing on ordinary white note paper. The number of words that can be written depends entirely on the writer, ranging from ten to thirty-five a minute, the round rolling style proving the one best adapted for rapidity.

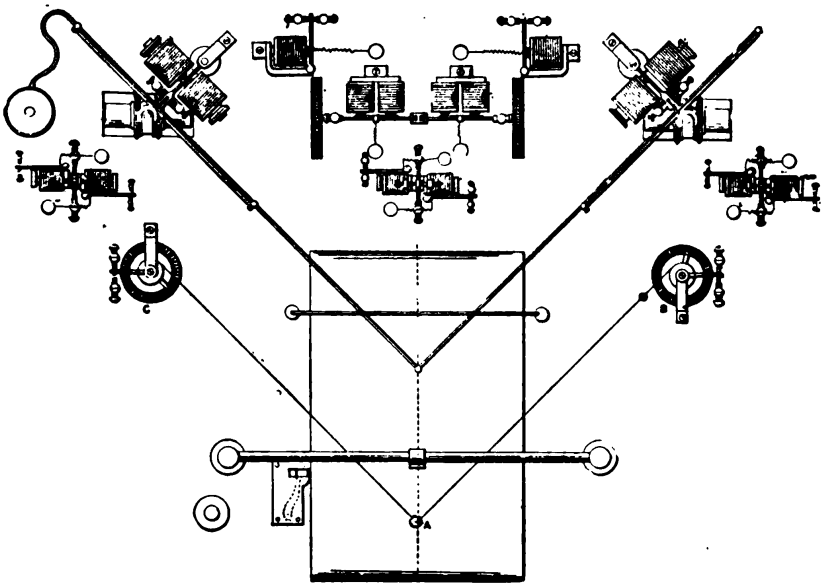
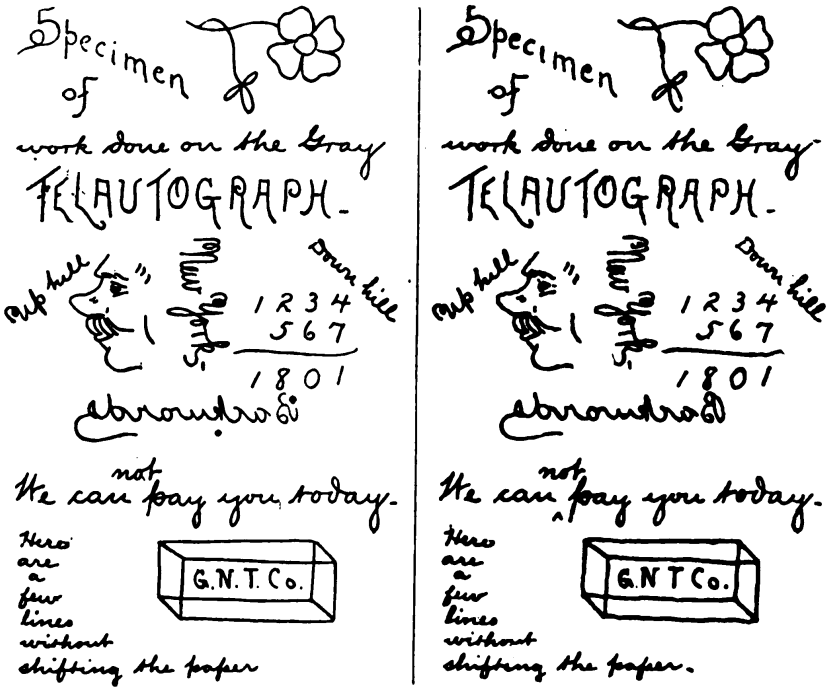


DIAGRAM OF THE TELAUTOGRAPH.

The interior mechanism is not displayed, but the accompanying diagram from the patent records will afford a fair idea of the electrical and mechanical features. It is understood that no attempt will be made to introduce it for long distance work at present, but to utilize it between neighboring towns, between the factory and the office, to transmit telegrams from local to main



offices and for work of a similar character, all of which it gives fair promise of doing efficiently and with comparative economy.

In addition to several of the perfected instruments connected up by coils of wire representing circuits one mile in length, there will also be displayed in the Gray pavilion a sample of each of the earlier forms of the telautograph and many sections of abandoned mechanism that to the interested visitor may prove an object lesson illustrating step by step the evolution of the perfect machine. Dr. Elisha Gray is the exhibitor in conjunction with the Gray Electric Company.

THE American Institute of Electrical Engineers will be well represented at the Exposition, and their headquarters in the Electricity building will probably prove the rendezvous for many important meetings as well as personal and social engagements. The following letter from the committee having the matter in charge outlines the proposed programme, and also calls attention to the important historical collection to be displayed in the rooms of the Association :

NEW YORK, March 29, 1893.

To the Editor of WORLD'S FAIR ELECTRICAL ENGINEERING :

DEAR SIR,— At the last meeting of the council of the American Institute of Electrical Engineers, the Committee on Ways and Means, who have charge of matters pertaining to the official headquarters of that body at the World's Fair, presented a report and the committee was instructed to insert a notice in the technical papers calling attention to the fact that the institute had secured through the coöperation of the authorities at the World's Fair two rooms adjoining the offices of the Electrical Department in the Electricity building. These headquarters are now being furnished, and the secretary of the institute, Mr. Ralph W. Pope, will be in general charge of the headquarters during the exhibition, and the committee, on behalf of the council, wish to extend an invitation, not only to the members of the American Institute of Electrical Engineers, but to any and all of our foreign friends of the electrical profession who may visit our shores during the coming World's Fair, to use these rooms as their headquarters. Letters may be addressed in the care of the secretary at the headquarters, and in the furnishing of the rooms, facilities will be given for writing letters, meeting friends, reading technical papers which will be placed on file, leaving their parcels and securing general information upon the Electrical Congress and other meetings, and World's Fair matters generally. The rooms will be equipped with a long distance telephone and telegraph service, fire protection, and the authorities have promised to place one or more members of the Columbian guard at the headquarters. The institute has decided to

place in these rooms various objects of great scientific and historical interest, such as photographs, pictures, autograph letters, rare electrical books, models, instruments, etc. These things will be properly classed and arranged, and the committee request that all parties having objects which would prove of interest in value in this connection to communicate with the secretary, Mr. Pope, at the headquarters of the institute, 12 West Thirty-first street, New York city, or with the chairman of the committee, Mr. William J. Hammer, 527 Temple court, New York city. As we are somewhat limited for space the committee will be compelled to select only objects which are not too bulky and which are of great interest and value, and they propose to make the headquarters of the institute one of the most interesting features of the Electrical Department of the World's Fair. As the time is very limited, the committee trust that a prompt response will be given to this call, and that all the members of the institute will feel a personal interest in seeing that the exhibit made shall be as full and as valuable as possible. The secretary was instructed by the council at the last meeting to extend an official invitation to the foreign electrical societies to avail themselves of the privileges of the institute.

WM. J. HAMMER,
FRANCIS R. UPTON,
W. A. KRIEDLER,
Committee.

THE Western Union Telegraph Company will display some historical exhibits of great value, including the original instrument made by Charles Morrison, of Renfrew, Scotland, in 1753, having a separate wire for each letter and a pith ball at the termination of each wire. The original Morse instruments will be shown; also, sections of the original cable that Morse laid underground in Baltimore, together with relics and instruments left by Henry and by Faraday, Miss Mary Henry, a daughter of Professor Henry, having kindly loaned her father's collection to the Exposition officials. Then, there will be the original Wheatstone bridge; a model of the Great Eastern; sections of broken sea cables; the personal trophies of Cyrus W. Field, including medals, portraits, etc.

WORK on Edison's "Tower of Light" is well under way, and the lamp sockets will be wired up next week. This tower is 82 feet in height, 34 feet in diameter and, it is reported, 18,000 incandescent lamps will be placed in circuit, affording a golden blaze of glory typifying the incarnation of electricity. There are several hundred cities that have not so many incandescent lights

within their borders, and no single isolated plant in the country has that number. Thus, this tower forms a wonderful example of the progress of the industry, and will consume energy at the rate of 1,500 horse-power per hour.

INCLOSED by cables attached to oak posts made in the form of wire bobbins, the whole forming a rich and attractive appearance, is the exhibit of the Chicago Electric Wire Company, of Wilmington, Delaware, consisting of reels of wire ranging in size from the largest conductor down to No. 16, and so placed as to form a booth, over which is a protecting canopy surmounted by the well-known trade mark of that company. At the corners reels of wire form the pedestals supporting electroliers, and these in turn rest on solid oaken counters having richly carved deep panels on which appears in raised gold letters the words "Chicago Electric Wire Company." Displayed on the counters are coils of wire and samples of the insulating compound and specimens showing the various steps in the process of manufacture. The exhibit was designed and arranged by Mr. Cobb, who personally superintended the construction of the booth.

THE ELECTRICAL EXHIBITORS.

The following list of exhibitors in the Electricity building was prepared on April 10, and forms a fair index not only of the zeal and the good judgment displayed by Chief Barrett in securing the leading electrical manufacturers of the United States and of foreign countries to join in making a display that will prove to be all that the Exposition officials had in mind when they declared, two years ago, that the electrical exhibit would be the attractive card that would draw the masses into the grounds, but of the judicious pruning that has been required in order to have a display complete in every detail and one that will be of acknowledged value from an educational, historical and industrial standpoint rather than from one noted only for its spectacular effects.

It should not be forgotten that Chief Barrett's work was not in any manner lessened by the action of the local board in transferring to Machinery hall the power plant occupying 180,000 square feet of space, and which Mr. Barrett earnestly desired to have so placed under his control that close competitive tests could be made of the efficiency of the various systems, under circumstances that could admit of no controversy, and then publishing the tabulated data in such form as would best picture every detail of the cost of the product from the coal pile to the lamp and the motor. And as an offset to the expense that exhibitors would thus incur Chief Barrett proposed to distribute all the contracts for the lighting of grounds and buildings among them on a prorata basis at a figure that would be equitable and just and, while saving a large sum to the Exposition Company, would largely reimburse the exhibitors.

A further division of exhibits properly belonging in the Electricity building was decided on and much electric street railway material transferred to the Transportation building, while other classes were assigned space either in Machinery hall or in the Manufactures building.

Moreover, the many consolidations, transfers, and injunctions that have occurred or been brought about in electrical commercial circles during the last few months has still further added to the labor required on Chief Barrett's part. But it is needless to say that no one will be disappointed when the gates are thrown open, for the electrical exhibit will be all that its friends desire.

CHICAGO.

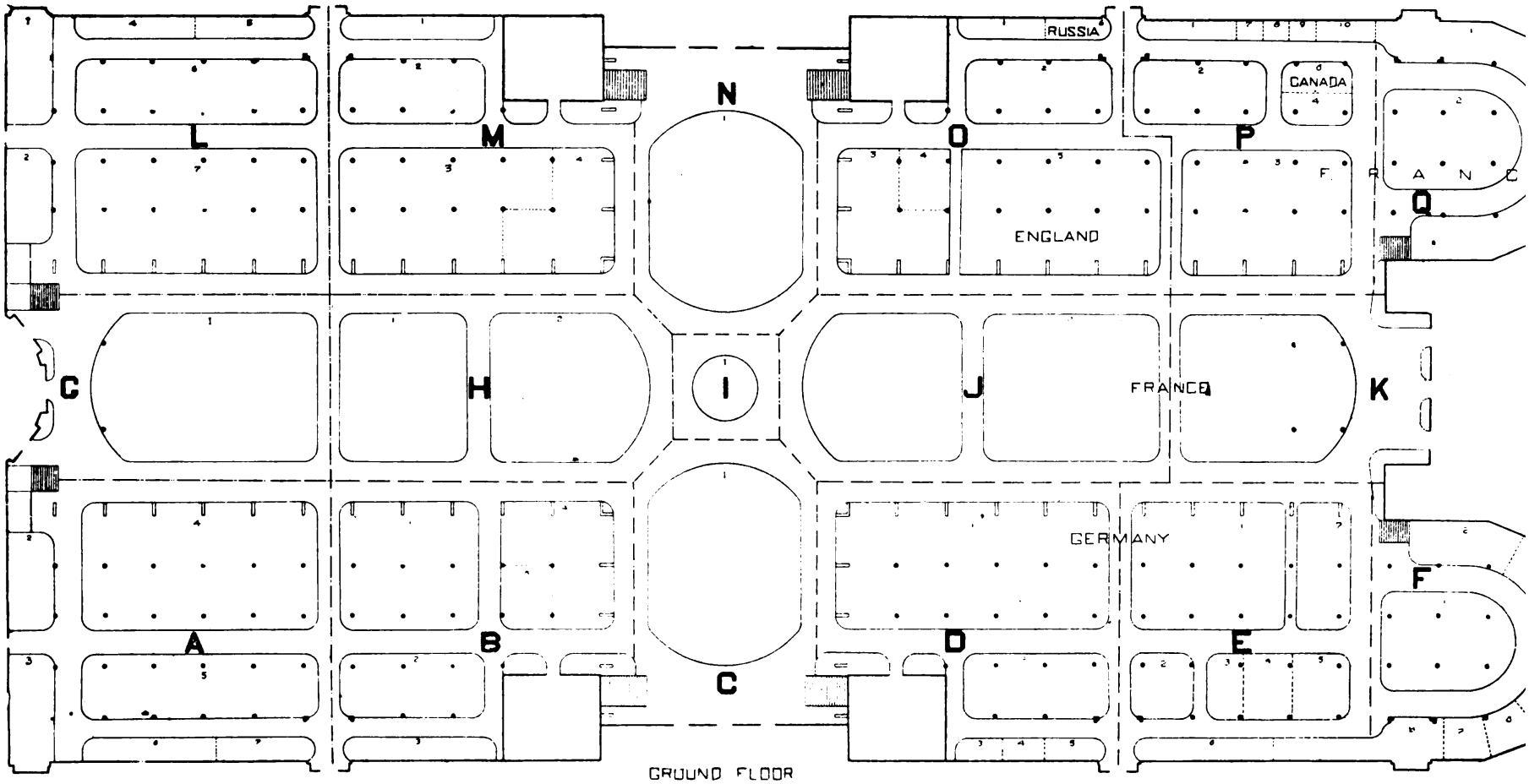
SEC.	SPACE.		
Z	1	Ansonia Electric Co	102 Michigan avenue.
T	9a	American Battery Co.	177 La Salle street.
—	—	Briggs, Orlando	227 South Clinton street.
S	16	Benham, A. D	200 South Clinton street.
T	3	Cutter, George	329 The Rookery.
U	8	Central Electric Co	118 Franklin street.
—	—	Cooper Electric Heater Co., The	301-303 The Rookery.
Y	14	Copenhagen Automatic Fire Alarm	Traders' Building.
F	5	Chicago Belting Co	30 West Randolph street.
—	—	Crane Elevator Co	219 South Jefferson street.
R	5	Dulaney Clock Co	79 Dearborn street.
Y	28	De Land, Fred	565 The Rookery.
L	5	Degenhardt, F. E	542 The Rookery.
Y	28	Electrical Engineering, World's Fair	565 The Rookery.
U	16	Electric Appliance Co	242 Madison street.
Y	36	Electrical Machine Co	1008 Title & Trust Building.
Y	18B	Edgerton, E. M	301 Sixty-third street.
E	3	Elwell-Parker Electric Construction Co	85 Washington street.
W	5	Gray, Elisha	425 Home Insurance Bldg.
T	4	Guillaume, Alfred	215 Dearborn street.
V	1	Gamewell Fire Alarm Telegraph Co	901 Ashland Block.
—	—	Griffin Wheel and Foundry Co.	508 Phoenix Building.
U	17	Hall, Charles Frederick	Grand Hotel, Plymouth.
L	4	Hanson & Van Winkle Co	35 South Canal street.
—	—	Healey & Millet	225 Wabash avenue.
Y	9	Houlehan, James	489 North Clark street.
S	5a	Hurd, John F	
Y	19	Illinois Alloy Co	41 Portland Block.
V	3	International Automatic Light and Power Co	316 Phoenix Building.
S	10	Knapp, George S	1017 Chamber of Commerce.
T	16B	Knight Automatic Boot Blacking Co	
S	20	Lee, Charles E	9 Lakeside Building.
E	5	Mather, A. C	169 Adams street.
D	4	Munson Belting Co	36 South Canal street.
U	11B	McCaskey, Alfred S., & J. A. Ellis	
W	3	McIntosh Battery and Optical Co	141 Wabash avenue.
S	8	National Engraving Machine Co	Pontiac Building.
Y	40	Newman Clock Manufacturing Co	279 Dearborn street.
S	2	North American Phonograph Co	Masonic Temple.
—	—	Oehring, A. J	124 Fremont street.
U	1	Owens, Dr. A	201 State street.
D	5	Page Belting Co	Lake street.
T	8a	Pennock Battery Electric Light and Imp. Co	334 Dearborn street.
—	—	Police Telephone and Signal Co	902 Ashland Block.
T	6	Pumpelly, James K	205 South Canal street.
U	11A	Pratt Electro Medical Supply Co	75 Madison street.
R	8	Railway Equipment Co	Pullman Building.
D	3	Schieren & Co., Charles A	42 South Canal street.
—	—	Sosman & Landis	236 South Clinton street.
P	2	Standard Electric Company	625 Home Insurance Bldg.
T	20	Standard Paint Co., The	542 The Rookery.
T	7	Strowger Automatic Telephone Exchange	301 The Rookery.
T	9b	Tate, D. D	Englewood.
S	4	Todd, John T	340 Dearborn street.
A	7	Taylor, Goodhue & Ames	Dearborn street.
T	23	Union Electric Works	207 South Canal street.
A	4, 5	Western Electric Co	227 South Clinton street.
V	8	Western Union Telegraph Co	La Salle street.
Y	13B	Wullweiber & Co., O. L	49 Franklin street.
—	—	Webster Manufacturing Co	195 South Canal street.

JACKSON PARK.

M	3	Fort Wayne Electric Co., E. A. Barnes	Electricity building.
B	4	General Electric Co., E. J. Spencer	Electricity building.
C	1		
H	2		
J	1		
M	4		
O	3		

CLEVELAND, OHIO.

T	5	Reliance Steam Gauge Co	East Prospect street.
—	—	Swan Lamp Co	Belden street.
Y	45	Webb, G. F., Dr	251 The Arcade.
P	9	Elliott Electric Co.	78 E. Prospect street.
L	6-7	Brush Electric Co., The	Belden street.
U	15	The Ford-Washburn Storelectro Co	122 Water street.
Y	20	National Carbon Co., The	Willson avenue.



OF ELECTRICITY BUILDING.

NEW YORK.

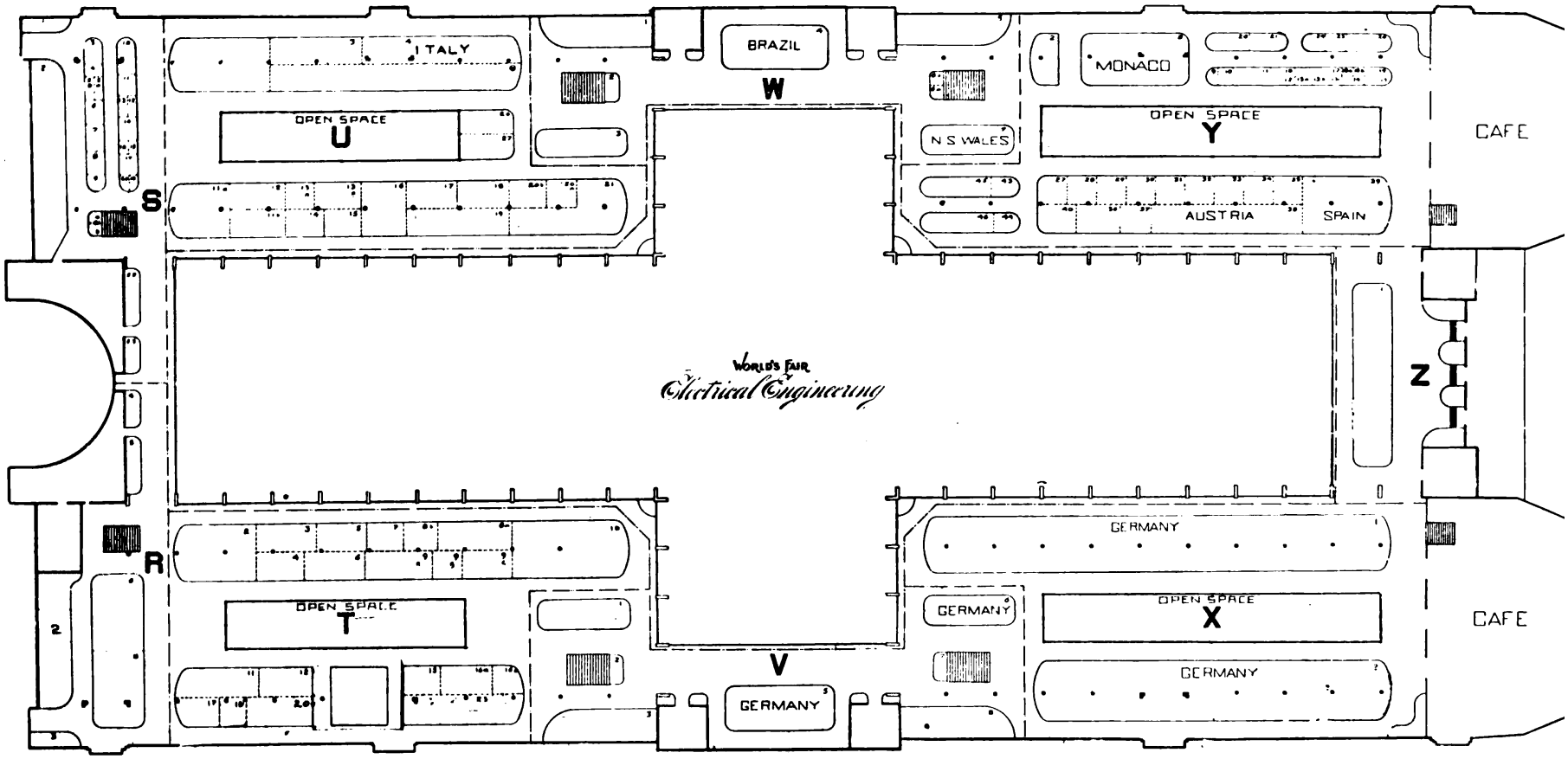
SEC.	SPACE.		
T	2	Brixey, W. R.	203 Broadway.
Y	43	Bates Manufacturing Co.	
A	2	"C. & C." Electric Motor Co.	402 Greenwich street.
L	1	Crocker-Wheeler Electric Co.	430 West Fourteenth street.
Y	2	Commercial Cable Co.	1 Broadway.
U	19	Electric Selector and Signal Co.	45 Broadway.
B	5	Excelsior Electric Co.	42 Broad street.
P	1	Electrical Conduit Co.	32 Nassau street.
F	8	Greely, E. S., & Co.	5-7 Dey street.
—	—	General Fixture Co.	292 Avenue B.
S	3	Hirleman, Charles J.	117 MacDougale street.
S	11	India Rubber Comb Co.	9 Mercer street.
—	—	Ingersoll-Sergeant Drill Co.	10 Park place.
U	21	Johns Manufacturing Co., H. W.	87 Maiden lane.
V	7	Leclanche Battery Co.	117 East Thirty-first street.
—	—	Lidgerwood Manufacturing Co.	96 Liberty street.
—	—	Meywurtz, E. B.	104 East Twenty-third street.
—	—	Murphy T. J.	136 Liberty street.
T	11	New York Insulated Wire Co.	15 Cortlandt.
5	12	North American Electric Co.	14 Ann street.
5	23	Non-Magnetic Watch Co.	177 Broadway.
—	—	New York Air-Brake Co.	115 Broadway.
—	—	National Conduit Manufacturing Co.	Times Building.
—	—	National Automatic Fire Alarm Co.	
—	—	Okonite Co.	13 Park Row.
I	1	Phoenix Glass Co.	42 Murray street.
S	9	Roessler & Hasslacher Chemical Co.	73 Pine street.
R	1A	Ringler, F. A., & Co.	21-23 Barclay street.
—	—	Stephenson & Co., John, Limited	47 East Twenty-seventh st.
F	3	Union Electric Co.	45 Broadway.
W	2	Vetter, J. C., & Co.	104 East Twenty-third street.
—	—	Vail, W. A.	136 Liberty street.
—	—	Van Nuis, C. S.	136 Liberty street.
P	10	Wing, L. J., & Co.	126 Liberty street.
U	27	Waite & Bartlett Manufacturing Co.	143 East Twenty-third street.
F	2	Zucker & Levett Chemical Co.	14 Grand street.
—	—	Sperry Electric Railway	29 Broadway.

BOSTON.

G	1	American Bell Telephone Co.	125 Milk street.
—	—	Campbell Electric Supply Co	104 High street.
D	2	Electrical Forging Co.	163 Oliver street.
Y	15	Electric Heat Alarm Co.	113 Devonshire street.
U	13B	Electric Gas Lighting Co	48 Congress street.
—	—	Eco Magneto Clock Co.	620 Atlantic avenue.
—	—	Robinson Electric Truck and Supply Co.	620 Atlantic avenue.
—	—	Rowell-Potter Safety Stop Co.	7 Arch street.
O	2	Thomson Electric Welding Co.	Fiske Building.
—	—	Walworth Manufacturing Co	14 Oliver street.
M	1-2	Anthony Electric Inst. Co	116 Bedford street.
—	—	Whitney Electric Inst. Co.	146 Franklin street.

PHILADELPHIA.

R	2	Consolidated Electrical Storage Co., The.	Drexel Building.
W	1	Electric Advertising and Display Mfg. Co	134 South Seventh street.
Y	45	Franklin Electrical Appliance Co.	
O	4	Heisler Electrical Co	Drexel Building.
Y	12	Marcus, William N	218 North Second street.
5	22	Paiste, H. T	10 South Eighteenth street.
E	7	Queen & Co., Jas. W.	1010 Chestnut street.
U	27	White Dental Manufacturing Co., E. S., The	
—	—	Wharton, Wm., Jr., & Co. (Ins.)	Twenty-fifth street and Washington avenue.
A	3	Westinghouse Electric and Manufacturing Co.	Pittsburgh.
B	1-2		
F	1		
H	1		
—	—	Acme Filter Co.	St. Louis.
—	—	Wagner Electric Manufacturing Co.	" "
U	13A	Botome Turner, D	Indianapolis.
F	4	Commercial Electric Co.	"
L	2	Jenney Electric Motor Co.	"
U	12	Munson Lighting Conductor Co.	"
S	14	American Graphophone Co.	Washington, D. C.



GALLERY
OF ELECTRICITY BUILDING.

MISCELLANEOUS.

SEC.	SPACE.		
T	15	Chicago Electric Wire Co	Wilmington, Del.
—	—	Jackson & Sharp Co	" "
S	15	Meeker, Dr. G., 244 Mulberry street	Newark, N. J.
R	16	Weston Electric Inst. Co., 114 William street	Newark, N. J.
—	—	American Engine Co	Bound Brook, N. J.
—	—	Burton Electric Co	Richmond, Va.
E	2	Belknap Motor Co	Portland, Maine.
F	7	Curtis Electric Manufacturing Co	Jersey City, N. J.
S	21a	Casper, Louis	Cheyenne, Wyo.
—	—	Diamond Electric Manufacturing Co	Peoria, Ill.
T	10	De La Frere, Malcolm	Minneapolis, Minn.
Y	21	Elgin Acoustic Telephone Co	Elgin, Ill.
U	14	Eureka Tempered Copper Co	Northeast, Erie Co., Pa.
B	3	Eddy Electric Manufacturing Co	Windsor, Conn.
Y	18A	Electro Med. Battery Co., 128 Main street	Kalamazoo, Mich.
J	1	Edison, Thomas A	Orange, N. J.
S	21B	Electric Specialty Co., The, 1720 Larimer street	Denver, Colo.
T	8B	Electric Co	Canton, Ohio.
Y	46	Gault & Co., N. C., 626 W. King street	Winona, Minn.
W	1	Holmes, Nathaniel L	Ann Arbor, Mich.
Y	10	Jaeger, Charles L	Maywood, N. J.
V	2	K. A. P. Electric Novelty Co., The	Lacrosse, Wis.
S	5B	Koch, G. F., 2406 W. Chestnut street	Louisville, Ky.
—	—	Lawton, Harry A. and Kennon Mott	Brunswick, Ga.
—	—	Lawrence Machine Co	Lawrence, Mass.
—	—	Lake Erie Engineering Works	Buffalo, N. Y.
U	20A	McNeill Tinder Electric Co	Winchester, Ky.
—	—	McIntosh, Seymour & Co	Auburn, N. Y.
U	20B	Phelps, A. H., M. D	Glen Falls, N. Y.
U	18	Powell Wm. Co., The, 50 Plum street	Cincinnati, Ohio.
—	—	Pass & Seymour	Syracuse, N. Y.
Y	15	Rauscher, John, 134 Concord street	West St. Paul, Minn.
—	—	Russell & Co	Massillon, Ohio.
—	—	Rockford Electric Manufacturing Co	Rockford, Ill.
Y	13a	Sponholz, Carl L., 126 School street	Lowell, Mass.
Y	13C	Striemer A., 6411 Oakes avenue south	Superior, Wis.
Z	1	Stanley Electric Manufacturing Co	Pittsfield, Mass.
Y	17	Standard Electric Signal Co	Rochester, N. Y.
—	—	Steam Stone Cutter Co	Rutland, Vt.
—	—	Thomson-Houston Electric Co	Lynn, Mass.
—	—	Taylor Electric Truck Co., 556 Fulton street	Troy, N. Y.
R	4	Utica Electric Manufacturing and Supply Co	Utica, N. Y.
—	—	White, James	Glasgow, Scotland.
—	—	Fein, C. & E	Stuttgart, Germany.
—	—	Carpenter Enamel Rheostat Co	Bridgeport, Conn.
—	—	Platt, O. S	" "
T	17	Waddell-Entz Co., The	" "
Y	24	Billings & Spencer Co	Hartford, Conn.
F	6	Jewell Belting Co	" "
—	—	Crowell Gilmer, 294 Graham street	Brooklyn, N. Y.
S	19	Empire China Works, 144 Greet street	" "
—	—	Merrill Bros., 465 Kent avenue	" "
—	—	Bemis Car Box Co	Springfield, Mass.
P	4	Electron Manufacturing Co	" "
—	—	Case Engine Co., J. L., The	New Britain, Conn.
—	—	Graton & Knight Manufacturing Co	Worcester, Mass.
V	3	Washburn & Moen Manufacturing Co	" "
Y	11	Hope Electric Appliance Co	Providence, R. I.
T	12	New England Butt Co	" "
S	6	Devey, Matthew H., 353 Parker street	Chester, Pa.
E	4	Arnold Manufacturing Co	" "
—	—	Pelton Water Wheel Co., 121 Main street	San Francisco, Cal.
5	13	Willoughby, Charles, P. O. Box 1845	" "
T	16a	Norwich Insulated Wire Co	Norwich, Conn.

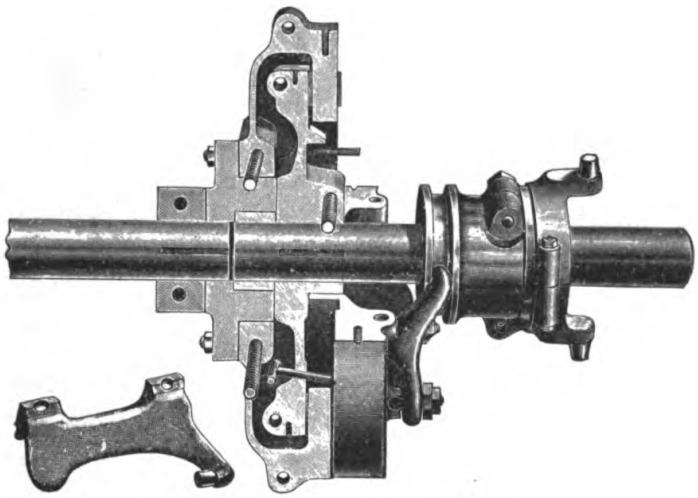
GOVERNMENT EXHIBITS.

	SEC.	SPACE.
Austria	Y	38
Brazil	W	4
Canada	P	6
England	O	5
France	Q	1
	J	2
	K	1
	P	3
Germany	X	1, 2
	V	5, 6
	D	1
	E	1
N. S. Wales	W	7
Russia	O	6
Spain	Y	39
Monaco	Y	8
Italy	U	4

— — Indicates a joint display with some other exhibitor.

MACHINERY HALL NOTES.

THE Rice Machinery Company, the Chicago representatives of the Dodge Manufacturing Company, will supply the Exposition Company with about 8,000 feet of turned steel shafting ranging from three inches to six inches in diameter, and the necessary complement of Dodge double brace pattern hangers with 30-inch drop, and Dodge patent ball and socket type of pillow blocks, both blocks and hangers being provided with chain oil bearings that insure perfect lubrication under all ordinary conditions, and renders further attention necessary only at intervals of thirty days



DODGE COMPRESSION COUPLING.

or longer. About four hundred of the Dodge safety compression couplings will be required, the essential features of which include strength, simplicity and safety. The pulleys used will include both the Independence wood split pulley and a special form of iron center constructed pulleys. This contract will afford the Rice Company ample opportunity to display the simplicity, efficiency and quality of workmanship of their well known standard make of machinery.

RUSSELL & COMPANY'S EXHIBIT.—In Machinery hall will be found six Russell automatic engines. Of these one is a double

tandem compound 15 by 24 by 24, running 125 revolutions per minute, with a balance wheel 120 by 60 inches, weighing 36,000 pounds, while the total shipping weight of these two engines complete amounts to 89,172 pounds. These engines will develop 600 horse-power with a water consumption, as accounted for by the indicator, of 14½ pounds per horse-power per hour running condensing, and 20 pounds of water per horse-power per hour when running non-condensing. The admission and cut-off valves are triple-ported slide valves, balanced by a layer of steam being admitted between the working faces of the valves and their seats in such a manner as to insure easy working without any danger of leak. The exhaust valves are cylindrical in shape and oscillate in their chambers at a time when the pressure upon them is at its minimum, a "dwell" of sufficient length to tide over the period of admission and greater part of expansion of the steam in the cylinder being introduced in this valve mechanism.

A compound 13 by 20½ by 20 S. V. engine, running 180 revolutions per minute, with a balance wheel 90 by 30 inches, weighing 8,565 pounds, while the shipping weight of this engine equals 26,335 pounds. This engine will develop 200 horse-power with a water consumption, as accounted for by the indicator, of 18 pounds per horse-power per hour when running condensing and 22 pounds per horse-power per hour when running non-condensing.

Two simple 17 by 24 four-valve engines, running 150 revolutions per minute, each having a balance wheel of 108 by 20 inches, weighing 5,786 pounds; shipping weight of each of these 26,100 pounds. The economical load that each of these engines will carry is 200 horse-power, at a water consumption, as accounted for by the indicator, of 18 pounds per horse-power when running condensing and 22 pounds per horse-power per hour when running non-condensing. These engines are equipped with the same valve arrangements described for the double compound.

One simple 13 by 18 S. V. engine, running 235 revolutions per minute, with a balance wheel 72 by 12 inches, weighing 3,000 pounds. The shipping weight of this engine is 10,000 pounds and it will carry economically a 100 horse-power load, with a water consumption of 22 pounds per horse-power per hour when running condensing and 26 pounds per horse-power per hour when running non-condensing. The valve of this engine takes steam from underneath and is held to its seat by enough steam

being admitted into the chest to accomplish this purpose without overloading it; the steam is admitted to the cylinders through "carry-over" double ports, and the exhaust is accomplished through a "D" passage.

These engines have been designed to meet the requirements of the highest attainable economy in steam consumption, and represent results of a long experience in the building of automatic engines. The finish, general style and appearance will compare favorably with the best work at the Exposition, and it is needless to say that all the material entering into the construction of these engines has been carefully selected, frequent tests made as to strength, and, lastly, the engines themselves have been tested before leaving the factory to insure success from the start after they get to their destination.

As mentioned in the January number of this magazine, the Stirling boilers will occupy the space adjoining the Babcock & Wilcox boilers in the boiler room of the power plant, and we rejoice with the Stirling company that the decision of Judge Grosscup was so entirely in their favor, as stated in the following communication:

To the Editor,—As there has been considerable misunderstanding and misrepresentation about the litigation in Chicago of the water-tube boiler manufacturers, called the "Temporary Association," against the World's Columbian Exposition for an injunction to prevent the installation of Stirling boilers as an exhibit, we trust you will allow us the privilege of an explanation through your columns.

The Temporary Association is composed of six water-tube boiler manufacturers formed for the purpose, apparently, of filling the main boiler room at the World's Fair to the exclusion of other reputable manufacturers and one in particular. Additional space was created which the Stirling Company applied for on equal terms with all, but were refused, the engineer in charge stating that the space had been promised to the Babcock & Wilcox Company. The Stirling Company appealed to the Council of Administration, were sustained and contract entered into. After many ineffectual efforts to change this decision, the Babcock & Wilcox Company filed a bill for an injuction to shut out the Stirling boilers, thus seeking to create a monopoly and throw the gates open for any exhibitor to exclude a competitor. Some of the allegations and assertions of this bill as to the character of the Stirling type of boilers are so ridiculous that it is hardly possible to believe the author in his right mind. Were we to enumerate them it could but create a smile of contempt that such methods should be thought of by any intelligent competitor. The Master-in-Chancery decided in favor of the

Babcock & Wilcox Company, but Judge Grosscup, of the United States District Court, brushed this decision aside, stating that Mr. Sargent, the World's Fair engineer, had no authority to make a verbal agreement. Mr. Sargent expressly testified that he told the Babcock & Wilcox Company that the promise would first have to be approved by the Council of Administration. As a matter of fact it never was submitted to the council and the Babcock & Wilcox Company were never advised that it had been approved by that body. The judge holds that the Babcock & Wilcox Company failed to establish any one of the essential allegations of their bill. The injunction prayed for was denied with costs against complainant.

Judge Grosscup emphatically states that the bill is evidently filed for the purpose of excluding Stirling boilers as an exhibit, and the evidence in the case and all the circumstances also show very clearly that the object of the Babcock & Wilcox Company in filing their bill was to prevent an exhibit of the Stirling along side of and in close comparison with the Babcock & Wilcox boilers. This seems to us a very remarkable confession of weakness on the part of our competitors, for if, as conceded by them, the only value to be derived from retaining the space is the advertising features, and the Stirling type is what they claim, their boiler could have no better advertisement than to be placed alongside of the Stirling where a comparison could be made; but they did not desire that, and to prevent a comparison they filed their bill. We are now therefore on record as seeking the closest comparison with all competitors and they are on record as endeavoring by every means in their power to shut us out.

Four Stirling water-tube boilers are being erected in the main boiler room of Machinery hall as rapidly as possible, and when you visit the Fair we trust you will not fail to see them. Yours truly,

(Signed) THE STIRLING COMPANY.

TELEPHONE AND TELEGRAPH INTERESTS.

THE Bell Telephone Company makes this instrument statement for the second month of the fiscal year and two months:

Shipments to February 20, 7,750; returned, 5,123; net output, 2,627. Net output since December 20, 4,852; instruments in use February 20, 556,591, showing an increase of 41,223 since the same date last year.

TELEPHONE MILEAGE IN THE UNITED STATES.—The following statement shows the mileage of wire in use in the United States for telephonic communication on January 1 of each year:

	Miles.		Miles.
1882	52,205	1888	202,617
1883	83,105	1889	243,764
1884	115,265	1890	279,941
1885	137,223	1891	331,642
1886	155,791	1892	381,554
1887	172,928	1893	421,027

—*Electrical Engineer, March 29.*

THE American Bell Telephone Company's annual report for the year ending December 31, 1892, contains the following data: Telephones in the hands of licensees under rental, 552,720, an increase of 40,313 over the same date in the previous year. Total number of exchanges 812, a gain of 24; number of branch offices 539, a gain of 30; wire mileage on poles 201,259, a gain of 21,120; wire mileage on buildings 14,980, a gain of 26; mileage of wire underground 90,216, a gain of 19,882; mileage of submarine wire 13,336, a gain of 307; and the total wire mileage was 307,791, a gain of 41,335. The number of employés increased 1,594 during the year, bringing the total up to 9,970. There were subscribers on January 1, 1893, 232,140, a gain of 16,123 during the year. Estimated number of exchange connections 1,868,189 daily, or about 600,000,000 per annum. The average number of daily calls per subscriber throughout the United States $8\frac{1}{20}$. The wire mileage of extra territorial lines, which are lines connecting exchanges on January 1, 1893, was 133,002, an increase for the year of 17,914. The average number of toll connections per day is reported at 40,772, or about 13,000,000 yearly, and the total toll revenue was $1,897,258.33. To this is to be added $643,436.77, the gross earnings of the American Telephone and Telegraph Company. The net earnings of $3,411,674.78 were added to the surplus on hand January 1, 1892, $2,151,011.61, making a total of $55,562,686.39; and this amount was appropriated as follows: Regular dividends, 1892, $1,927,227; extra dividends, 1892, $991,863; reserve, general depreciation, $400,000; reserve, depreciation of instruments, $92,584.78; surplus accounts, December 31, 1893, $2,151,011.61.

TELEPHONE STATISTICS.—The subjoined table, which we take from the *Journal Télégraphique* of January 25, contains information on telephonic extension in thirteen different countries, comprising a population of more than 200,000,000 of inhabitants (the 250,000,000 of natives in India, who apparently do not use the telephone, are excluded). The figures printed in italics represent the results obtained by private companies :

Country.	Number of localities provided with networks.	Length of wire serving for telephonic communication.	Number of subscribers' or public stations.	Number of urban and trunk-line conversations.	Mean per subscriber and per day.
		kilom.			
Germany	337	137,000	71,212	208,938,691	9.7
Austria	53	6,651	1,832	1,261,894	2.2
do	*11*	*33,728*	*9,389*	*16,163,057*	*5.7*
Hungary	6	5,753	2,113	7,235,320	11.4
do	*8*	*889*	*770*	*808,933*	*3.8*
Belgium	4	1,502	346	238,810	2.3
do	*12*	*12,290*	*6,257*	*1,686,900*	*0.9*
Luxembourg	45	1,881	970	1,247,067	4.2
Netherlands.....	*15*	*1,212*	*3,809*	*7,031,656*	*6.1*
Russia	9	4,132	1,155	1,428,706	4.1
do	*11*	*23,068*	*6,070*	*9,564,137*	*5.2*
Sweden	102	22,763	9,863	18,590,827	6.2
do	*217*	*20,000*	*28,504*	*16,902,104*	*1.9*
Switzerland	149	24,363	12,679	6,639,303	1.7
Tunis	1	140	106	91,510	2.8
British India	125	1,609	401	.....	...
do	*6*	*3,396*	*1,180*	*1,258,349*	*3.5*
Japan	2	2,309	839	1,667,203	6.6
American Bell Telephone Co.....	788	428,994	206,017	500,000,000	7.6
Total.....	1,901	731,680	363,512	800,754,467	7.

It will be seen from this table that there is one subscriber for about six hundred inhabitants, and one network for 100,000 inhabitants. The general mean of conversations per subscriber and per day is seven, a little lower than that of the American Bell Telephone Company.

As regards France, where the telephone passed into the hands of the government on September 1, 1889, considerable progress has lately been made in that country. On December 31, 1891, 112 networks had been opened for the public, forty-six were in course of construction, and the number of subscribers was 18,191. The total amount obtained for subscriptions amounted to 5,574,892 francs (£223,000) during the year 1891, the largest share of which was contributed by Paris, where there are about ten thousand subscribers. During the year 1892 108 fresh localities have requested the administration to establish telephonic communication, so that the number of authorized networks at the present moment is 266. At the time the government took over the telephones from the Société Générale des Téléphones, the latter had under their control eleven networks, and twenty-nine were managed by the state. In the space of three years, as

will be seen, concession has been granted for 226 new networks, or about seventy-five per year.—*London Electricity, February 17.*

GERMAN TELEPHONE STATISTICS UP TO THE END OF 1891.—The statistics given below include the whole of Germany, Bavaria and Würtemberg included, which have separate administrations :

Number of urban networks		330
Number of trunk lines		360
Length of urban lines		11,533.5 km.
Length of wire of urban networks		112,435.2 "
Length of trunk lines		6,346 9 "
Length of trunk wires		25,852.1 "
Number of telephone exchanges		255
Number of telephone stations		70,283
Comprising :		
End stations	66,656	
Intermediary	3,283	
Stock Exchange cabins	109	
Public call offices	235	
	70,283	
(In 128 localities.)		
Number of subscribers		63,600
Number of apparatus		80,572
Number of conversations carried on during the year 1891		273,355,146
Comprising :		
Urban conversations	235,734,116	
Trunk line conversations	37,621,030	
	273,355,146	

—*London Electricity, March 10, 1893.*

TELEGRAPH STATISTICS.—The following are the latest statistics on the telegraph service, taken from the *Journal Télégraphique*, of January 25 :

	Number of Telegrams.			Receipts.
	Interior.	International.	Total.	
				Francs.
European countries...	171,050,000	47,485,000	218,535,000	257,402;000
Countries outside Europe	80,652,000	13,310,000	93,962,000	276,705,000
Total	251,702,000	60,795,000	312,497,000	534,107,000
Total of preceding year	238,543,000	57,474,000	296,017,000	524,194,000
Or an increase of.....	13,159,000	3,321,000	16,480,000	9,913,000

The total network of telegraphic connections in the world has increased during the year 1892 by 81,000 km. of lines, and about 340,000 km. of wire ;

nearly 10,000 new telegraph offices were opened to the public, and the working apparatus have increased by about 12,000. At the end of the year the total length of telegraphic connections for public use was about 1,500,000 km. of lines and 4,350,000 km. of wire. Railway telegraphs and telephonic connections are not included in these figures.

These connections are distributed over the various countries as follows:

	Total length in kilometers.	
	Lines.	Wires.
Countries belonging to the Telegraphic Convention.		
European countries	687,300	2,161,300
Countries outside Europe	194,500	494,700
Countries not belonging to the Telegraphic Convention.		
American Western Union	309,000	1,200,000
Other countries	95,000	250,000
Submarine cable companies	238,000	242,000
	1,523,800	4,348,000

The above-mentioned increase of telegraphic connections during the past year is distributed as follows:

	Lines.	Wires.
In European countries	30,720	122,530
In countries outside Europe	50,080	214,255
	80,800	336,785

Among European countries, Germany figures in these totals with 8,000 km. of lines, and 24,000 km. of wires; France, with 7,500 km. of lines, inclusive of telephone lines; Italy, with 1,100 km. of lines, and 6,000 km. of wires; and Great Britain, with 2,000 km. of lines, and 12,500 km. of wires. In the countries outside Europe, the Western Union Telegraph Company has increased the length of its lines by 9,000 km., and that of its wires by 100,000 km. The Central American and South American states, about which no detailed information can be obtained, also show an increase in the figures. Finally, as regards the cable companies, an important increase has taken place by the recent opening of a new communication between St. Louis in the Senegal and Brazil.

The submarine cables are extending at an extraordinary rate; in 1889 there were laid 9,500 km.; in 1890, 14,800 km.; in 1891, nearly 23,000 km. of new cables. This latter figure has only been surpassed once since 1849, the date of the laying of the first submarine cable in the channel, and that was in 1884, when more than 25,000 km. of cables were laid.

The total of 1891 comprises, in round numbers, about 3,600 km. of cables in European waters; 6,400 km. on the African coast and the far East; 7,000 on the northern and central coast of America; and 6,000 on the eastern and western coasts of South America.

As regards the financial results obtained, no accurate figures could be obtained, but there is no doubt that a large number of administrations work with a deficit, especially where the telegraph is in the hands of the state. In Great Britain, for instance, which enjoys the most favorable conditions of working, and where the traffic surpasses that of the largest European

states, and even of the Western Union Company, a surplus of 4,000,000 francs (£160,000), has not realized a sufficient income for paying the interest on the capital of 257,180,200 francs (£10,300,000), so far spent on the purchase and the first installation of telegraphs. Some of the private companies, however, are making a profit, and the net profit of the Western Union Company last year amounted to 3,800,000 francs (£1,520,000), representing an interest of 7¾ per cent on their share capital of $100,000,000.—*London Electricity, February 17.*

At the end of June last year there were 6,055 miles of telegraphs in Colombia, South America.

JAPAN.—During December last, 454,625 telegrams (4,257 foreign, and 450,368 home telegrams) were dealt with by the Japanese Telegraph Department; the receipts amounted to £22,565. In the workshops of the Japanese Telegraph Bureau, all the telegraph instruments and other supplies are made, wire being now the only material obtained from outside sources.

LAST year (1892) the Western Union Telegraph Company sent 62,387,000 messages, and its earnings were $23,706,000. The Postal Telegraph Company sent 9,335,000 messages, and its earnings were $3,187,000.

THE submarine telegraph system of the world consists of 142,790 nautical miles of cable. Government administrations own about one-tenth of this property, and the remainder is in the hands of private companies. The total cost of these cables is in the neighborhood of $200,000,000. The north Atlantic is crossed by eleven cables, all laid since 1870; five companies are engaged in forwarding telegrams between North America and Europe, and the total length of the cables owned by them, including coast connections, is over 30,000 nautical miles. The following schedule shows the number of nautical miles of cable operated by the government in the different countries of the world, leaving out fractions: Austria, 97; Brazil, 19; Belgium, 54; Canada, 214; Cochin China, 795; Denmark, 192; Dutch Indies, 488; France, 3,269; Germany, 1,579; Great Britain and Ireland, 1,599; Greece, 459; Holland, 59; India, 1,982; Italy, 1,027; Japan, 55; New Caledonia, 1; New Zealand, 196; Norway, 230; Queensland, 162; Russia in Asia, 70; Russia in Europe, 212; Senegal, 3; South Australia, 49; Spain, 135; Sweden, 88; Tasmania, 4; Turkey in Europe and Asia, 331; Victoria, 4. In addition to these there are twenty-five cables owned by private companies, their total length being 129,407 nautical miles.—*George G. Ward in The Independent.*

A BRIEF REVIEW OF SOME LEADING ARTICLES IN THE ELECTRICAL JOURNALS.

In the discussion which followed the reading of his paper on transformers before the London Institution, Doctor Fleming gave some tables showing the all-day efficiency of the Hedgehog as compared to a closed magnetic circuit transformer. He showed that with a single transformer, working with a load factor of about ten per cent, the all-day efficiency of each kind was about seventy-four per cent. For the purpose of comparing the total losses, including those due to the feeders, a case was assumed in which a primary feeder a mile long supplied four 6,000-watt transformers placed at the end of the feeder. When supplying four Hedgehog transformers, the twenty-four hours' loss in the feeders was calculated to be 2.65 kilowatt hours, and when supplying four Mordey transformers, .45 kilowatt hours. This would make the total losses due to the transformers and feeders for twenty-four hours 18.15 kilowatt hours in the case of the Hedgehog open magnetic circuit, and 15.79 kilowatt hours for the Mordey closed magnetic circuit transformer, showing a saving in twenty-four hours of 2.36 kilowatt hours in favor of the Mordey transformers. Mr. Swinburne has proposed decreasing the loss in the feeders when supplying open magnetic circuit transformers by using condensers, but Doctor Fleming found that none of the condensers submitted to him were free from dielectric hysteresis. One condenser tested, which was capable of supplying power to four 6,000-watt transformers, absorbed 120 watts. If this loss could be reduced to 100 watts, it would mean a loss in twenty-four hours of 2.4 kilowatt hours, so that there would be nothing gained by its use, as practically there would be as much power wasted in the condenser as could be saved in the mains. A comparison was also made between an alternating station, supplying current to a 24-kilowatt transformer one mile from the station, and a direct current system supplying twenty-four kilowatts on the three-wire system, at a pressure of 220 volts through a set of feeders a mile long, each feeding a set of low-pressure distributing mains with an assumed

load factor of ten per cent. Assuming a loss of forty per cent in the low-pressure feeder at full load, the all-day efficiency with the ten per cent load factor would be eighty-seven per cent; this would require cables equal to about 37-16. The high-pressure system would show an equal efficiency on the same load factor with cables equal to 7-16. Taking the difference in cost, including construction, cables, transformers, etc., and allowing for interest, depreciation and the energy wasted, it was assumed that the annual cost of the low-pressure direct feeder system would be $541, and of the high-pressure alternating feeder $468. With lower percentage voltage drops in the low-pressure feeders, the case becomes decidedly more favorable to high pressure. Any increase in the load factor also tends to increase the efficiency of the high-pressure system, as the transformer efficiency would be increased while the losses in the low-pressure feeders would be increased and the efficiency correspondingly decreased. The conclusion reached was that there was no room outside a radius of one mile for a continuous current station, and that the economical radius of supply was reached when the feeders had an average length of somewhat less than one mile, with load diagrams of ten per cent. It will be noticed that Doctor Fleming's calculations are based on the open magnetic circuit transformer tested by him, and that this transformer had a low efficiency, due to the core losses being several times the amount which theoretically they should be. But even if these losses can be greatly reduced, the actual efficiency of the open magnetic circuit would still be lower than the corresponding closed magnetic circuit transformer, as the C^2R losses in the mains would remain practically the same for a considerable variation of load, the effect of a variation of load being not so much to alter the actual value of the current as to simply alter the power by shifting the angle of lag. Any gain due to the higher efficiency at light loads would therefore be more than compensated for by the heavy losses in the mains at light loads. Doctor Fleming seems to think it will be a difficult matter to get a condenser which will not waste power in the dielectric to such an extent as to make it impracticable as a means of decreasing the total losses.

Professor Unwin's fifth lecture was devoted to the subject of transmission of power by compressed air. He stated that compressed air was the most formidable rival electricity had, and that for ordinary power purposes, exclusive of transit and lighting, enormously more work was being done by compressed air than by electricity. There were a few cases where power was distributed for industrial purposes by continuous current electrical systems, which were effective, but too costly. At present there was no case where power was distributed industrially by alternating currents, but only certain elements out of which such a system might be built. From the standpoint of present knowledge and past experience he believed that it might be asserted that power distribution, in cases where it was not merely a subordinate function of a lighting plant, and especially in cases where the work had been done previously by steam motors, which could be converted into air motors, could be more economically and more efficiently effected by compressed air than by electricity. In the *Electrical World* Mr. Carl Hering criticises this statement and says "Although Professor Unwin is a recognized authority on mechanical power transmission, we fear this last statement indicates that he is not an authority on electrical transmission." There can be no doubt but what Professor Unwin can fully substantiate his statement, for disregarding the question of convenience which might be raised against the practice of reheating, there is no doubt that compressed air can be transmitted for power purposes very economically when reheating is resorted to, it being possible to obtain an efficiency of from 80 to 100 per cent, depending on the amount of reheating and the efficacy of the apparatus. Professor Riedler's experiments show that when the air is heated before use the range of expansion is greatly increased, and the heat thus supplied is used from five to six times as efficiently as a similar amount would be in a fairly good steam engine. These results are confirmed by theory and have been amply demonstrated in practice.

Professor Unwin gives the cost of a horse-power hour as delivered by compressed air in Paris as about one cent when using old steam engines, and two cents when using small inefficient motors, and he thinks that still better results can be obtained by using motors specially designed for the work. Unfortunately, at the present time the Paris air company are in considerable difficulty. So far as he could learn, the supply of power by compressed air

was on the whole a perfectly successful operation, but the company was hampered by the fact that the compressed air power distribution was associated with a very unremunerative electric system, and while the distribution of compressed air was successful, the very costly electric lighting stations which belonged to the same company were worked far less successfully. He also refers to the complete failure of the compressed air system at Birmingham, and remarks that while one ought not to speak ill of the dead he thought the most serious engineering mistake made at Birmingham was in attempting to transmit compressed air through steel mains with ordinary lead joints which in this installation were heated up to 280 degrees during the day and allowed to cool down at night. No ordinary joint would stand that action and the result was a continual leakage. With all regard for Professor Unwin's respect for the dead, it would seem that as post-mortem examinations have proved so valuable, and as it is only by avoiding the mistakes of the past that we can progress in the future, the specific causes of the Birmingham failure would have been of interest. Mr. Hanssen, in *Engineering*, states that the changes in the temperature to which the Birmingham mains were subjected were sufficient to cause a daily expansion and contraction of almost a quarter of an inch for each fourteen feet of length.

Professor Unwin's statement that the Paris electric system is unremunerative is not at all strange. The plans as originally laid out contemplated the operation of sub-stations equipped with accumulators. These were to be operated by power conveyed from the central station by means of compressed air. There was considerable doubt at the time as to how this system could prove more economical than that usually adopted, and it would seem from Professor Unwin's statement that subsequent developments have not in the least dispelled this doubt. The commercial success of electric lighting has long since become an assured fact, and all failures can readily be traced to either errors in engineering or financiering.

Professor Unwin's sixth and last lecture deals with electrical transmission. In his first lecture Professor Unwin stated that he was not an electrician, but that there might be an advantage in approaching the subject with the bias of an engineer rather than of an electrician. He stated that electricians claimed they could do

nearly everything in the way of running machinery by electricity. He was quite willing to admit they could do all they claimed with one proviso, namely, that they were allowed unrestricted expenditure. The world, however, was not managed on these lines. In a good deal of what electricians said, they seemed to have forgotten two things, namely, that for many years past it has been quite possible to convey power very considerable distances by means of electricity, but it has not been done because it was too expensive; and, secondly, to be practically successful it was necessary that the power should be supplied finally at a cheaper rate than it could be generated for on the spot. In electric lighting a great deal has been accomplished, and the system seemed to be succeeding financially; but in some cases the electric light did not have to meet, even on the ground of expense, a very dangerous rival. In other cases the beauty and convenience of the light had often compensated for its extra cost as compared with gas. Electric traction had also been successful as far as he could discover; however, it did not appear that the cost of traction was much less than with horses, but greater speed could be obtained. In other directions the progress of electrical distribution of energy had been much slower. When the Niagara commission met two years ago there was in Europe only one installation where power was developed for the purpose of distribution as motive power to many consumers. Power was transmitted by an alternating current on the three-phase system at Heilbron, but the cost for power purposes was about 8 cents per kilowatt hour, and in November last only eleven motors, aggregating 32 horse-power, were connected to the mains, so it was quite an insignificant affair. Furthermore, Mr. Brown, the designer of the Lauffen dynamos, never spoke very strongly in favor of the transmission. He had said that one object of the Frankfort-Lauffen transmission was to show the advantages of the three-phase system, but it actually showed the disadvantages of complication in the line, generators and transformers. Looking to accomplished results, it would appear that from a steam station electricity could not be supplied for power purposes under $145 to $195 per year of 3,000 working hours. In every important case he had been able to discover, including some important mining installations in America, the power was initially obtained from water. There was no immediate prospect of a reduction in the cost of electrical distribution, and we had probably nearly

reached the limit of improvement in the steam engine. With gas engines there was a prospect of slightly reducing the cost at which power could be produced. He had endeavored to show that at present in central station working the conditions were very unfavorable to the cheap production of power by any form of heat engine. The fundamental difficulty was the variation in the demand for power and the expensiveness of any form of storage hitherto tried. The chief hope of reducing the cost of power distribution would be by combining the supply of as many demands as possible.

In proposing a vote of thanks to Professor Unwin, Professor Ayrton said he thought the matter had been put before them with perfect justice, but he thought it should be borne in mind that the question of electrical distribution of power was in its infancy while the other systems had been worked for years. He thought the price of electricity would continue to go down. He had just learned that the London Supply Company had reduced their charges to 8 cents per kilowatt hour, or only one-half what they charged a short time ago.

Professor Unwin's statements should not be construed too literally, as there can be no doubt but what under favorable circumstances power can be supplied from steam stations at a lower rate than that named. In fact, there are several stations in this country distributing electric power at from 4 to 5 cents per kilowatt hour.

Professor Unwin's treatment of the subject of electrical transmission may at first seem unfair and to be rather biased toward the mechanical transmissions. His statements certainly contain food for reflection. There can be no question that there is a tendency toward the adoption of electrical transmission to the exclusion of all other forms, and in the majority of cases the selection is a proper one, but it seems rather startling that after all that has been heard of electrical transmissions the fact remains that, barring the low-tension direct systems, distributing over extremely restricted territory and the less numerous installations, distributing over a more extended though still restricted district, using a direct current of 500 volts pressure, there is probably not a station in this country actually *distributing* power which is transmitted from

a distance on any of the numerous systems which have been proposed. Without detracting from what has been done toward this accomplishment, it would seem that with the present systems financial considerations do not warrant its being undertaken. If the complications of the three-phase system do not prove a drawback, and there is no particular reason why they should, the present aspect may be materially changed.

Professor Unwin's lecture brings to light another term which is capable of several interpretations, and which necessarily causes ambiguity. It is the term "horse-power per year." Unless the number of hours or the number of days, working at so and so many hours per day, is specified, it is difficult to tell what is actually meant.

Another term which may be considered in the light of a misnomer, is the term "efficiency" as applied to the transmission of power by compressed air when reheating is resorted to. The actual efficiency of transmission in a compressed-air system without reheating is the ratio of the power available at the point of consumption to the power expended at the station, and ordinarily varies from 40 to 50 per cent. If, however, the air is heated before being admitted to the motor, a much higher duty is obtained from a given amount of fuel than is possible by its consumption under a boiler in the ordinary manner. But as the energy imparted to the air is not transmitted to the point of consumption by means of the air, it is improper to ascribe the gain to the efficiency of transmission. It will readily be apparent how it is possible on this basis to have an efficiency of 100 per cent, and yet sacrifice considerable in transmission. But, though the results may practically amount to this, the efficiency obtained is not one of transmission, and it is manifestly unfair to compare simply on the score of efficiency the results thus obtained with those obtained in a system in which the power is all actually transmitted, there being several factors which tend to modify the results, such as convenience, etc.

The London *Electrician* gives the following recipe by which M. Moissan has succeeded in making artificial diamonds: He places about two hundred grams of a mixture of cast iron and carbonized sugar in a crucible of carbon resting in a bed of magnesia, the whole being contained in a block of lime. The mass is

subjected to a high temperature by the passage of an electric current for five or six minutes, the crucible and its contents are then plunged into cold water. The metal solidifies superficially, and the interior mass expanding as it cools becomes subjected to a high pressure under which the liquid carbon solidifies. On dissolving the nugget with acid, a number of microscopic diamond crystals are found.

Mr. Brown's recent description of his alternating current motors has caused considerable comment, and numerous claims to priority of invention have been advanced. There can be no doubt but what Mr. Brown was clearly anticipated in this line by both Prof. Elihu Thomson and Mr. Tesla. In Europe Mr. Arnold, of the Oerlikon Company, seems to have motors in use operating on practically the same principle as that described by Mr. Brown; they also closely resemble Mr. Brown's motors in construction and appear to differ only in the starting devices. The recent impetus given to this class of motors seems to be due more to the improvement in the details of construction rather than to any radical departure in principle. The London *Electrician* briefly describes the method suggested in 1891 by Messrs. Hutin and Leblanc, and which they claim to be the same as that suggested by Mr. Brown. The motors appear to be alike in the fact that no torque whatever is developed by the motor until the armature is set in motion; but whereas Mr. Brown only uses a single-wound armature, Messrs. Hutin and Leblanc employ one which is double wound. Prof. Elihu Thomson mentions the fact that he sent a motor to the Paris Exposition in 1889 which was built in accordance with the principle pointed out by Mr. Brown as arising from his own observations. He also describes a very simple experiment for illustrating the principle upon which such motors work. Professor Thomson thinks that had it not been for the comparatively high frequency in use in the United States a large extension of the use of such motors would have taken place ere this.

At the meeting of the National Electric Light Association at St. Louis, two papers on the transmission of power, by Dr. Louis Bell and Mr. C. S. Bradley, caused considerable discussion. The discussion was principally confined to the subject of the

transmission of power by alternating currents and especially the difficulty of operating motors on currents of single phase. Mr. Bradley frankly stated that he had tried to build motors of large size but had been unsuccessful. The difficulty encountered being excessive sparking at the commutator. Doctor Bell added that one of the first efforts to get an alternating motor which would be self-starting was made by Zipernowski and his associates. They encountered no serious difficulty in making the motor self-starting, but there was a continuous blaze at the commutator while starting. As far as he could tell, the motors being exploited abroad by Mr. Brown appeared to be practically those suggested some time ago by Professor Thomson and Mr. Tesla. They appeared to run well and give a good efficiency, but they did not start well. The broad distinction between single-phase and multiphase motors being that the single-phase motors do not start with sufficient facility to produce the required torque. The conclusion reached as a result of the discussion was that at the present time there was no practical motor suitable for power distribution with single phase alternating currents. The whole question of alternating motors seems to have been enveloped in more or less mystery. There seems to have been a general disinclination to give the results of experiment, and though we hear of numerous motors that are to make their appearance shortly, etc., the fact that they do not appear is very suggestive. In the discussions before the scientific societies the subject seems to have been approached with considerable diffidence. The technical papers publish from time to time articles describing different methods; but either leave a great deal to be inferred, the description being curtailed on account of patent matters, etc., or they are so involved in theoretical mathematics as to be seemingly beyond the elastic limits of the ordinary materials of construction, and nothing results but a tendency to create the impression that an entirely practical machine has been produced. It is refreshing to hear a frank statement like that of Mr. Bradley's and it cannot help but be beneficial in its results. So much has been said and written of the progress made abroad in this line that some curiosity existed as to Professor Forbes' opinion. His experience seemed to substantiate the conclusion of the American engineers, though his statements were very guarded. It is to be regretted that some of the enthusiastic advocates of single-phase motors were not

present, as it would have probably resulted in bringing to light a number of the practical difficulties which prevent the realization of theoretical principles. The high frequency used in this country is one obstacle that engineers abroad do not have to contend with, as the frequency commonly used there is much lower than that adopted in this country. There is a great demand for a practical motor, and its advent would not only affect the economical distribution of power, but would also greatly increase the efficiency of the present systems of transformer distribution, both by tending to equalize the load and by increasing the all-day efficiency of the transformers by decreasing the period of light load.

The London *Electrician* publishes an interesting article by Dr. Sumpner on the diffusion of light. While it has long been known that a light-papered room is easier to illuminate than one having dark paper, no figures from which the effect could be definitely calculated have heretofore been published. Dr. Sumpner shows that the diffused light may be several times greater than the direct light which produces it. Diffusion is also of importance in another way, for it alters the character of the illumination and makes it much more pleasant for the eye to endure. The absorbing effect of bright surfaces on the eye is not only unpleasant, but it causes the pupil to close up to a greater or less extent, and as the amount of light received by the eye depends not only on the intensity of illumination, but also on the area of the exposed portion of the eye, it is clear that any influence which causes a partial closure of the pupil of the eye produces the same effect as if the surrounding illumination were diminished. In estimating the usefulness of a diffusing globe account should therefore be taken of both the absorbing power of the globe and the increased exposing power of the eye. If the globe absorbs thirty per cent of the light, but at the same time so diffuses it that the pupil of the eye increases in diameter by twenty per cent and the area of the eye exposed by forty per cent, the amount of light received by the eye is actually increased and not diminished by using the globe. It is impossible to say to just what extent this effect takes place, but the general taste for the use of opal globes and other diffusers has probably some solid foundation not yet completely understood, and the fact that globes often absorb thirty or

forty per cent of the light produced is not so important as is often imagined. Another interesting fact mentioned is that a clean white-washed ceiling reflects as much light as an ordinary mirror, for although extremely good mirrors may be obtained which will reflect as much as ninety per cent of the light incident upon them, measurements made with common mirrors do not show a greater reflecting power than eighty-two per cent. This is practically the same as that shown by white blotting paper. One remarkable peculiarity of a diffusive reflector was noticed. An ordinary mirror reflects light almost equally well from all directions of incidence. With a diffusive reflector on the other hand, the light is mostly sent off in the normal direction. It is found that by placing a piece of common mirror immediately behind a glow lamp the candle-power of the lamp is nearly doubled, but if a piece of white paper be placed behind the lamp the candle-power will be far more than doubled. In the former case, however, the candle-power is doubled in all directions on one side of the mirror, while in the latter it is only true for directions in the neighborhood of the normal to the paper reflector. The plain white reflector is therefore more efficient than the plain mirror when it is desired to increase the light in one direction only. Dr. Sumpner's paper treats the subject very thoroughly and can be studied to great advantage.

In closing the discussion on Carl Hering's paper, "The Most Economical Age of Incandescent Lamps," read before the American Institute, the chairman made the following characteristic remarks: "There is much food for thought in Mr. Hering's paper, and its ideas as elucidated by him, and by the members who have favored us by discussion, are clearly of such practical importance that they merit the mature consideration of all who are interested in illumination by glow lamps, whether producers or consumers.

"While the idea of cutting short the life of an incandescent lamp is an absolutely new one to me, I have thought while listening to the discussions that it is one capable of much wider application than the paper suggests; for example, to human beings who have outlived their usefulness and whose life is devoted to making the lives of their fellow-creatures miserable.

"My early years were embittered by an aged and crabbed male relative, and I think now, if I had had then the suggestions

contained in Mr. Hering's paper I might have taken into consideration the circumstance that it was a waste of energy to keep him going, and that in the interests of law and order, seeing that he had reached that period which Mr. O'Keenan, impelled by the hereditary instincts of his race, calls the 'smashing point,' it was my duty to disconnect him."

Mr. E. G. Acheson describes in the *Electrical Engineer* the manufacture and use of the new substance known as carborundum. It will be remembered that Mr. Tesla has mentioned this substance several times in connection with his high frequency experiments. Mr. Acheson states that carborundum is a new material both to chemistry and the mechanical industries, and is purely a manufactured article, its name being derived from carbon and corundum. It is composed of carbon and silicon in the proportion of one atom of each to a molecule, the chemical formula being SiC. It is produced by passing a current of electricity through a mixture of carbon and sand, the current being of sufficient quantity to fuse the mass and cause the reduction of the contained silicon and its subsequent combination with a portion of the carbon. The cinder-like mass thus formed is washed and then crushed, the crystals formed by the crushing being afterward sorted into sizes or degrees of fineness suitable for commercial use. Carborundum is harder than emery and can be used to advantage in the mechanical industries for grinding purposes. It is also said to possess sufficient hardness to cut diamond, replacing the natural diamond heretofore used for that purpose.

Prof. Elisha Gray recently gave an exhibition of his perfected telautograph. The machines were shown in practical operation, both in Chicago and New York. The demonstration was a most interesting one from a scientific point of view, and the beautiful and ingenious instrument excited a great deal of admiration. As yet no details of the means employed to operate the machine have been published. The patent office specifications, however, describe in a general way the method used. While there is nothing new in the principle by which the results are accomplished, the details display electrical and mechanical skill of the highest order. When one considers the complex movements used in writing, the difficulty of reproducing them by mechanical means is readily apparent,

and though all complex curves and movements can be separated into numerous simple movements, their very number causes complication. In the Gray telautograph the reproduction is accomplished by purely mechanical and electrical means, and to separate the complex movements into their component parts, no less than eight or ten distinct motions are required. To accomplish these without serious complication, requires the use of several independent wires. When watching the movement of the receiving pen of the telautograph it certainly appears marvelous that the complicated movement of the transmitting pen can be so faithfully reproduced, and the results attained rather than the means adopted are more apt to appeal to one. Probably the first question suggested to the ordinary mind is: What are the commercial possibilities of such an invention? There can be no doubt that it accomplishes the results intended and that it is truly a marvel of inventive ingenuity and mechanical art, but there still remains the question of its commercial adaptability. In telegraphy the modern tendency is toward greater speed and greater economy in the use of wires. To accomplish this we have the duplex and quadruplex, enabling several operators to use the wire at the same time, and a further advance in the Wheatstone automatic duplex. In these systems but one wire is employed, and the aim has been to use it to its full capacity. In ordinary telegraphy twenty-five words per minute is considered a high average. In the Wheatstone system speeds of from 150 to 300 words per minute are daily attained on the long overland circuits in the United States. The question of introducing a machine which necessitates the use of two or three wires and the speed of which is limited by the speed of the handwriting is a difficult one from a purely commercial standpoint. There is also a factor of complication which is a serious one in practice. It is very difficult in modern telegraph practice to get skilled talent for the salaries ordinarily paid. Any machine which requires the services of an expert to insure its operation presents a very undesirable feature. Though the machine may not be complicated, when one considers the work required of it, the fact that it possesses many parts which require fine adjustment makes the practical man hesitate to recommend it. If three wires are required, and the speed of transmission is limited to thirty words per minute, an average of only ten words per minute per wire is attained, or about one-half the speed of transmission on the Atlantic

cables. Under peculiar circumstances, where it is necessary to reproduce an original diagram, sketch or signature, the telautograph would prove of great service; but as to its use commercially, the fact of its low speed, its complication and the delicacy of adjustment which must be required, are apt to prove serious drawbacks, and its practical introduction on a large scale will be watched with considerable interest.

Lieut. E. J. Spencer has a very nice advertisement of the General Electric Company in the March number of the *Illustrated World's Fair*, bearing the title of "Electricity at the World's Columbian Exposition." Following are two of the paragraphs:

When Chicago wanted arc and incandescent lights, power generators and motors, she advertised the fact, and called upon the American industry to make her competitive bids for this service. She asked under stringent specifications for 6,000 arc lights. A single electrical concern offered to take the entire contract. She asked for 90,000 incandescent lights. A single concern offered to take this contract. She asked for 3,500 horse-power of electrical generators. A single concern offered to take the entire contract, while five small concerns offered their generators practically free of cost, and divided up the aggregate of 3,500 horse-power (more than the aggregate of the Paris syndicate) among themselves.

The Exposition asked for the free equipment of its Electricity building by exhibitors. The General Electric Company offered a single combined engine and dynamos of capacity equal to half the capacity of the service plant at Paris.

It is true that Mr. Spencer's company offered to supply all the arc lights and all the incandescent lights called for in the competitive bids. It is also true that his company secured none of the incandescent lighting, and had to be satisfied with what one of the "five small concerns" was willing to let it have in the line of arc lighting. It was the small concern that made the price and set the pace for Mr. Spencer's company. The "combine" bid $42 an arc light and accepted $20 a lamp, a price that was established by the Standard Electric Company, of Chicago, whose action saved the directory more than $100,000. For the incandescent lighting the "combine" bid $18.50 a lamp, but through the efforts of a citizen of Chicago another "small concern" stepped in and lowered the price to $5.95 a lamp, thereby incidentally effecting a saving to the stockholders of the snug sum of a million dollars.

The Electricity building will be lighted by many exhibitors, and the strenuous efforts now being put forth by the "combine" to have an exhibit worthy of a combination of capital aggregating $50,000,000 indicates the high value they place on the advertising merits of an exhibit at the Columbian Exposition. Truly, it is an ill wind that blows no good. Had the "combine" secured the lighting contracts, possibly they might have rested content. Losing those contracts, they decided on having the finest exhibit the world has ever dreamed of, a series of exhibits that will awaken the workers of all nations to the possibilities in the practical application of electricity, if carried through on the grand scale on which they have been projected.

ELECTRICITY AT THE WORLD'S COLUMBIAN EXPOSITION.—To America belongs the honor of holding the first exposition depending upon electricity alone for its lighting. The Louisville Exposition of 1883 was lighted with 6,000 Edison incandescent lamps of 16 candle-power each. This was the first instance also of an entirely incandescent installation. It constituted one of the strongest attractions of the exposition. The little electric glow lamps at that time were a novelty to the public.

The New Orleans Exposition successfully combined the electric arc and incandescent systems in its services. The horticultural exhibits were lighted by the arc system. It was here that it became noticeable that under the white light of the electric arc the beauties and colors of the flowers were visible as with no other illuminant excepting sunlight.

Paris in 1889 astonished the entire world by her exposition lighting. To effect the same on the scale determined upon, the French Minister of Public Works, under a special enactment of the republic, organized a syndicate of prominent manufacturers of electrical apparatus. To each of the firms composing the syndicate was assigned a specific portion of the buildings in which to furnish light. But Paris did not light more than one-fifth of the entire exposition. She installed less than 1,100 arc lamps; she had less than 9,000 incandescent lamps. She had no service distribution of power by electricity. Paris had less than 4,000 horse-power of electrical machinery installed in service and exhibit plants. She had but 3,000 horse-power installed in the electrical service plant. The largest single dynamo installed was of 400 horse-power capacity.

* * * * * *

The Exposition at Chicago will fairly show the mechanical and electrical industry as it exists today. But four years will have elapsed from the time of the Paris Exposition. Yet the development of that four years has made possible the marvelous display of 24,000 horse-power of boiler capacity transformed into electrical power for the service of the Exposition in its myriads of decorative incandescent lights, its thousands of light-giving

electric arcs, its beautiful ever-varying electric fountains, the concentrated beams of the powerful search lights; the silent, swiftly moving electric launches and a multitude of motors of all sizes, performing all the complicated duties of the Exposition service, and turning over in active operation the otherwise dull, inert displays of hundreds of exhibitors.

In service and exhibit plants the marked modernizing feature will be the oil fuel plant. The oil will be delivered directly from tank cars into secure storage tanks beneath the surface level of the ground, and piped thence to the boiler plant. The supply to the furnaces will be automatically regulated by an electrical device actuated directly by the steam pressure. Should the demand for steam increase and the pressure consequently diminish, this device will open the drafts of the furnaces and increase also the supply of oil. Should the boiler pressure increase to the point of blowing off, this device will diminish the oil supply and close the drafts.

The next marked feature noticed will be the advent of large slow-speed dynamos directly driven by engines with the Corliss valve gear. In the power house of the intramural railway the General Electric Company will have a single armature on the shaft of a Reynolds-Corliss compound engine, which at seventy-five revolutions per minute will develop 2,000 electrical horse-power.

In the service plant the General Electric Company will have a triple expansion vertical marine type of engine directly driving two armatures — one at either end of the engine shaft. This will be used for service on the Edison three-wire system, and is capable of developing under 160 pounds steam pressure 1,500 horse-power.

It may be asked, what has become of gas as an illuminant? I think I may safely say that the child born in this quadro-centennial year will scarcely know it in that capacity. But, as with electricity, its field will broaden, and in its capacity as a fuel it will become the solution of the smoke nuisance. Who knows but that it will give us a more efficient engine, and one of its future missions be the breaking of the fetters now imposed by that peculiar fuel-eating characteristic of steam — a large latent heat of evaporation? — *Lieut. E. J. Spencer, in The Illustrated World's Fair.*

A SYNOPTICAL INDEX OF CURRENT ELECTRICAL LITERATURE.

ALTERNATING CURRENT APPARATUS.

(See Electro-Physics.)

(See Power Transmission.)

"Non-Synchronous Motor for Ordinary Alternate Currents." By E. Arnold. (A reply to C. E. L. Brown's letter.) London *Electrician*, Feb. 17.

"Single-Phase Alternating Motors." By Elihu Thomson. (Reply to C. E. L. Brown's article on non-synchronous motors for alternating currents, and describing the Thomson Single-Phase Alternating Current Motor exhibited at the Paris Exposition of 1889.) London *Electrician*. March 17.

"Non-Synchronous Motors for Ordinary Alternating Circuits." By E. Arnold, chief engineer, Maschinenfabrik Oerlikon. (Details of Oerlikon standard motors, with diagrams of windings, etc.) *Electrical Engineer*, March 22.

"The Brown and Hutin-Leblanc Alternate Current Motors." (Brief summary of the work of MM. Hutin and Leblanc. Also editorial comment.) London *Electrician*, March 3.

"The Present Position of the Alternating Motor Problem." Editorial, concluding "all indications point to the induction motor first invented by Elihu Thomson as the motor of the future." London *Electrician*, Feb. 3.

"Alternate Current Motor Design." By John F. Kelly. (Commenting on Dr. Louis Bell's remarks at the St. Louis meeting regarding the design of certain two and three phase alternating current motors.) *Electrical Engineer*, March 15.

"Non-Synchronous Motors for Ordinary Alternating Currents." By L. Gutmann. (A reply to C. E. L. Brown's letter, and claiming to have antedated Brown's work.) *Electrical Engineer*, March 29.

"On Testing and Working Alternators." By W. M. Mordey. (A paper read before the Institution of Electrical Engineers. With discussion and editorial comment.) London *Electrician*, March 3, 10, 17.

"The Design of Transformers and Choking Coils." By James Witcher. (Admirable suggestions serviceable in designing transformers and coils.) London *Electrician*, March 17.

"Recent Improvement in Transformers." (Editorial comment on Fleming's reports on the increased efficiency in transformers at light loads.) *Electrical Engineer*, March 22.

"Theory of the Transformer." By F. Bedell and A. C. Crehore. (Part I, introductory; magnetic effect of a current; work done in moving a magnetic pole; to find the magnetic potential at any point due to an electric current; work done in carrying a pole around a circuit; magnetizing force of an ampère turn; law of the magnetic circuit.) *Electrical World*, March 25.

"Experimental Researches on Alternate Current Transformer." By Dr. J. A. Fleming. (Abstract of discussion of Doctor Fleming's paper read before the London Institution of Electrical Engineers.) And full editorial comment: "We are loth to believe that the result is so greatly in favor of continuous currents as his calculations show." London *Electrician*, Feb. 17.

"High and Low Tension Systems." (Editorial comment on the discussion of Doctor Fleming's paper.) London *Electrical Engineer*, Feb. 17.

"Influence of Frequency on the Working of Alternate Current Transformers." (With tables and curves of frequency, output, efficiencies, etc., and statement that "The output of an alternate current transformer is proportional to the ⅜th power of the frequency. Hence it will vary only slowly with varying frequency.") By Charles Steinmetz, *Electrical Engineer*, March 1.

"An Induction Coil for Alternating Currents." By R. W. Wood. (Details for building powerful coil at an expense of about $20.) *Scientific American*, March 11.

BATTERIES, PRIMARY.

"Heating in Voltaic Cells." By T. H. Moras. (With curves showing the current output and temperature of small chromic acid and Grove cells discharging continuously through a circuit of .06 ohm external resistance.) London *Electrical Review*, Feb. 24.

"Alabaster and Others Versus Medical Battery Company." (Editorial comment on the final outcome of suit brought by an electrical belt manufacturer (Harness) against the London *Electrical Review*.) London *Electrical Engineer*, March 10.

"Alabaster and Others Versus the Medical Battery Company." (Full report of trial ending in a victory for the *Electrical Review* with damages at £1,000 and costs.) London *Electrical Review*, March 10.

"The E. M. F. of the Postoffice Standard Cell." By a Foreign Correspondent. (Details results of tests of Daniell's cells giving higher E. M. F. than the usually accepted 1.07 volt.) London *Electrical Review*, March 10.

"Primary Batteries." (Description of the Leclanché-Barber cell.) London *Electrical Review*, March 17.

BATTERIES, STORAGE.

"Storage Batteries in Practice." By J. K. Pumpelly. (A paper read before Chicago No. 1 N. A. S. E., February 9. *Stationary Engineer*, Feb. 25.

"Storage Batteries, Secondary Cells or Accumulators." By W. B. Shaw. (A paper read before the Montreal Electric Club, Feb. 20.) *Canadian Electrical News*, March.

"Storage Cells for Amateurs." By C. L. Wooley. (With details for making.) *Scientific American*, March 4.

"Storage Batteries for Isolated Plants." (Remarks of Doctor Bell, T. Carpenter Smith and Mr. Hammer in discussing Professor Forbes' paper on thermal storage.) *Electrical World*, page 178, March 11.

"The Scott-Sisling System for Accumulator Installations." By W. B. Sisling. (With diagram of connections.) *Electrical Engineer*, March 1.

"Present Status of the Storage Battery." By J. K. Pumpelly and C. Sorley. (A paper read before the Chicago Electric Club March 20, followed by tests of the battery, conducted by Mr. Sorley, and later by Mr. T. G. Grier and Mr. B. J. Arnold, the results showing over ten per cent above claims.) *Western Electrician*, April 1.

"The Storage of Electrical Energy." By Prof. George F. Barker. (General reference to various cells exploited, to the apparent defects, suggesting remedies, and as "the underlying principle is sound," looking for final commercial success.) The *Independent*, March 2.

BIOGRAPHICAL.

"James I. Ayer." (Extended notices, and portraits.) *Electrical Review*, Feb. 25; *Western Electrician*, March 4; *Electrical World*, March 4.

"Brainard Rorison" (with portrait.) *Electrical Review*, Feb. 25.

"Nikola Tesla." By J. A. M. (A psychological and scientific study of the man.) With portrait. *Electrical Review*, March 25.

Professor Elisha Gray (with portrait.) *Electrical World*, March 25.

"Some Interesting Farmer-Wallace Reminiscences." By Charles Stowell. *Electrical Engineer*, March 29.

"The Life and Inventions of Edison." By A. and W. K. L. Dickson. Third paper. (A handsomely illustrated serial, the first paper appearing in the November number, with new portrait of Edison; fifth paper, illustrating the Menlo Park laboratory in the winter of 1879; Edison and his chief assistants at Menlo Park in 1878; the Edison odoroscope, and Edison's micro-tasimeter.) *Cassier's Magazine*, March.

George F. Porter (with portrait). *Electrical World*, March 4.

Cyrus O. Baker, Jr. (with portrait). *Electrical World*, March 4.

Charles A. Baldwin (with portrait). *Electrical Review*, Feb. 25.

C. E. Farrington (with portrait). *Electrical Review*, Feb. 25.

J. A. J. Shultz (with portrait). *Electrical Review*, Feb. 25.

S. G. Booker (with portrait). *Electrical Review*, Feb. 25.

Edward A. Armstrong (with portrait). *Electrical Review*, March 11.

Schuyler S. Wheeler (with portrait). *Electrical Engineer*, Feb. 22.

Herbert A. Wagner (with portrait). *Western Electrician*, March 4.

Fred G. Schlosser (with portrait). *Western Electrician*, March 4.

D. W. Guernsey (with portrait). *Western Electrician*, March 4.

Capt. Robert McCulloch (with portrait). *Western Electrician*, March 4.

Prof. F. E. Nipher (with portrait). *Western Electrician*, March 4.

W. L. B. G. Allen (with portrait). *Western Electrician*, March 4.

C. R. Scudder (with portrait). *Western Electrician*, March 4.

E. J. Bagnall (with portrait). *Western Electrician*, March 4.

J. H. Rhotehamel (with portrait). *Western Electrician*, March 4.

Louis Nahm (with portrait). *Western Electrician*, March 4.

Col. E. D. Meier (with portrait). *Western Electrician*, March 4.

P. L. Rose (with portrait). *Western Electrician*, March 4.

C. P. Lampel (with portrait). *Western Electrician*, March 4.

William Wurdack (with portrait). *Western Electrician*, March 4.

A. D. Newton (with portrait). *Western Electrician*, March 4.

A. H. Eddy (with portrait). *Western Electrician*, March 4.

M. E. Baird (with portrait). *Western Electrician*, March 4.

William Richardson (with portrait). *Street Railway Journal*, March 4.

Gen. T. T. Eckert (with portrait). *Electrical Review*, March 18.

John H. Lillie (with portrait). *Street Railway Review*, March.

Andrew S. Hallidie (with portrait). *Street Railway Review*, March.

John H. Bass (with portrait). *Street Railway Review*, March.

M. S. Robinson, Jr. (with portrait). *Street Railway Review*, March.

"The Wizard's Pantheon." By J. Mount Bleyer, M.D. (A romance dedicated to Thomas A. Edison.) *Electrical Review*, March 18.

CENTRAL STATION, THE.

(See Alternating Current Apparatus.)

(See Corporations.)

(See Gas.)

(See Insurance.)

(See Municipal Lighting.)

"On the Determination of the Insulation Resistance and of Faults in Electrical Plants During the Working." By Dr. O. Froelich. (Illustrating methods of measurement, testing, etc.) London *Electrician*, Feb. 10, 17 and 24.

"Latitude and the Load-Factor." By E. Tremlett Carter. (Showing how the economical operation of the station is affected by latitude, etc.) London *Electrician*, Feb. 24.

"The Diffusion of Light." By W. E. Sumpner, D.Sc. (With a table of reflecting powers of various substances.) London *Electrician*, Feb. 3, 10.

"The Electric Lighting of Singapore." (Statement regarding cost, etc.) London *Electrician*, Feb. 10.

"Concentric Wiring." By Sam Mavor, M.I.E.E. (Advocating the adoption and detailing the advantages of concentric wiring.) London *Electrician*, Feb. 17.

"The Arrangement of Combination Stations." By H. K. McCay. *Street Railway Gazette*, March 4.

"Transformers and Substations." By W. H. Trentham. London *Electrical Engineer*, Feb. 3.

"Hot Water Storage." By W. H. Booth. London *Electrical Review*, Feb. 17.

"The Largest Arc Light Plant in the World." (Details of installation, operation and management of Mr. Ayer's St. Louis station, containing seventy-eight Wood arc dynamos and five 3,000-light Slattery alternating machines.) *Electrical Review*, Feb. 25.

"Some Experiences with the Alternating System." By R. H. Stirling. (A paper read before the National Electric Light Association, detailing the principal features of interest in the consolidated company's station at Denver, with discussion, including Prof. Edward Weston's remarks.) *Electrical Review*, March 11.

"Thermal Storage for Central Stations." By Prof. George Forbes, F.R.S. (A paper read at the St. Louis meeting of the National Electric Light Association, with discussion by T. Carpenter Smith, Mr. Stillwell and others.) *Electrical World*, March 11.

"The Christiania Central Station." (Details showing station capacity for 24,000 lamps of 8 candle-power, a Tudor accumulator plant of 154,800 watt hours, and 40 arc lamps.) London *Electrician*, March 3.

"The Havre Central Station." By Julius Maier, Ph.D., and A. P. Haslam, A.I.E.E. London *Electricity*, March 3 and 10.

"Cost of Electric Lighting at Topeka, Kansas." (Elaborate table showing cost of operating station for each month from November, 1889, to December, 1892, the average cost per lamp for month being $7.75, and the average cost per lamp per 100 hours being $3.86.) *Engineering News*, March 23.

"Power Catechism for Practical Engineers." (Questions and answers.) *Power*, February, March and April.

"Some Electric Light Statistics." *Electrical Industries*, March.

"Combination Stations: A Symposium." (Contributions from C. J. Field, D. C. Jackson, Dr. Louis Bell, J. H. Vail, M. J. Wightman, Prof. E. P. Roberts and Prof. Geo. D. Shepardson.) *Street Railway Gazette* March 4.

"The Lauffen-Heilbronn Central Station." By Julius Maier, Ph.D., and A. P. Haslam, A.I.E.E. Details of construction with plan and elevation of power plant showing turbines and generators, etc.) London *Electricity*, March 17.

"Grounding the Neutral Point of Electric Light and Power Lines." (Abstract of discussion at a meeting of the Berlin Elektrotechnische Verein, between W. v. Siemens and v. Dolivo Dobrowolsky, wherein the latter is reported to have held the insulated conductor at Lauffen carrying a potential of 20,000 volts.) *Electrical Review*, Feb. 25.

"Light and Power Stations—XIV." By Robb Mackie. (Suggestions regarding service connections, etc.) *Electrical Review*, March 4.

"Rules for Electric Light Work." (Full text of rules prepared by James I. Ayer to govern employés of the Municipal Electric Lighting and Power Company, St. Louis.) *Electrical Review*, March 4.

"Electrical Features of St. Louis." (With portraits of J. I. Ayer and others and illustrations of lighting and railway plants.) *Western Electrician*, March 4.

"Testing Arc Circuits." By A. H. Manwaring. (Describing device consisting of a series of resistances and a cut-out switch, in use in several stations.) *Electrical World*, March 4.

"The Design of a Central Station for Incandescent Electric Lights." By Prof. E. P. Roberts. *Electrical World*, March 4 and 25.

CORPORATIONS.

"Morals of Corporations." By E. A. Armstrong. (A paper read before the National Electric Light Association at St. Louis.) *Electrical Review*, March 11.

"Woodhouse and Rawson." (Editorial comments on proposed meeting to consider resolutions in favor of voluntary liquidation and reconstruction.) London *Electrical Engineer*, March 10 and 17.

DYNAMO ELECTRIC MACHINERY.

"Theoretical Elements of Electro Dynamo Machinery—XIV. By A. E. Kennelly. *Electrical Engineer*, Feb. 1 and 8.

"Electromagnetic Theory." By Oliver Heaviside—XLIV, XLV. London *Electrician*, Feb. 24, March 10.

"Electric Light and Power—VII." By Arthur F. Guy. (With diagrams showing magnetic circuit of the dynamo, etc.) London *Electrical Engineer*, Feb. 10, 17.

"Wrought Versus Cast Iron for Field Magnet Frames." By A. D. Adams. (A paper read before the National Electric Light Association at St. Louis.) *Electrical Review*, March 11.

"A Wire Gauge Chart for Determining the Ampère Turns on Shunt Magnets." By W. R. C. Corson. *Electrical Engineer*, March 1.

"Variations in Resistance." By R. A. F. (Commenting on Fernando Sanford's article: "A Necessary Modification of Ohm's Law," in the

Philosophical Magazine, giving the variations in resistance of copper wire on changing the surrounding medium.) *Science*, March 17.

"What is a Dynamo Machine?" By J. A. Kingdon. (Suggestions for ascertaining the exact meaning of the term dynamo machine, and defining it as "a self-exciting machine for transforming mechanical energy into electrical energy by the generation of continuous currents.") London *Electrician*, March 3.

"Sparking at Commutators — Continued." By F. M. Weymouth. (With diagrams showing plan of armature and commutator and brushes properly and improperly placed.) London *Electrician*, March 3, 10, 17.

"Modern Dynamo Efficiency." (Editorial remarks to the effect that, while electrical efficiency is easily attained, the so-called commercial efficiency is more difficult, while "financial efficiency is as yet unrecognized, but should be the ambition of the dynamo builder.") London *Electrician*, March 10.

EDUCATIONAL.

"The University of Wisconsin." By David B. Frankenburger. (A complete historical and descriptive illustrated article.) *New England Magazine*, March.

"The Armour Institute, Chicago." (Brief description of building and organization.) *Electrical Engineer*, March 8.

"The 'Series Method' as Applied to the Technical Professions." By Howard Swan. (A lecture delivered before the City Guilds Institute Old Students' Association, February 22, detailing the newly introduced method of M. Gouin, of Paris, of teaching languages, and the relation of this method to the technical professions. Briefly, the method consists of associating a mental picture with each technical expression.) London *Electrical Engineer*, March 3.

"Electrical Laboratory, University of Minnesota." (Brief description.) *Western Electrician*, March 18.

"Electrical Engineering." By Prof. Francis B. Crocker. (Reference to special courses in electrical engineering provided by many colleges.) The *Independent*, March 2.

ELECTRO-CHEMISTRY.

(See Electro-Metallurgy.)

"The Electrolytic Production of Chlorine and Soda." By Emile Andreoli. (Discussing the paper on the "Electrolytic Production of Chlorine and Soda," read by Messrs. Bevan and Cross before the Society of Chemical Industry, and concluding that "the production of chlorine and soda by the electrolysis of chloride of sodium is an accomplished fact.") London *Electrical Review*, Feb. 24.

"The Applications of Ozone." From a correspondent. (Extended details regarding production and application of ozone and illustrating different types of generators.) London *Electrical Review*, Feb. 24, March 3 and 17.

"Palladium Plating." (Trade note, containing some historical data.) London *Electrical Review*, Feb. 24.

"Ionisation." (Editorial reference to J. Traube's adoption "of the hypothesis of electrolytic disassociation in order to explain the behavior of aqueous solutions of metallic salts," in *Berichte der Deutschen Chemischen Gesellschaft* (Vol. XXV, pages 2,989–2,993.) London *Electrical Review*, Feb. 17.

"Note on the Purification of Mercury." By M. W. Jaeger. From *La Lumière Electrique*. (Details of the purifying processes the mercury is subjected to prior to being placed in instruments intended for exact measurement.) London *Electrical Review*, Feb. 17.

"Electric Manufacture of Chloral." (Reprint of details from *Revue de chimic Industrille*.) London *Electrical Engineer*, March 10.

"Carborundum: Its Manufacture and Use." By E. G. Acheson. (Describing the process of manufacture of this brilliant crystalline substance known to chemists by its formula of SiC.) *Electrical Engineer*, March 3.

"Electricity for Chemical Laboratories." (Comment on an arrangement described by Dr. Karl Elbs in the *Chemiker Zeitung*.) London *Electrician*, Feb. 3.

"Liquefaction of Ozone." (Brief abstract of the details of various experiments resulting successfully.) London *Electrical Review*, March 10.

ELECTRO-METALLURGY.

"The Position of Aluminum." (Reference to cost and methods of reducing aluminum from $12 a pound in 1886 to 50 cents in 1892, and suggesting that other methods than electrical must be investigated before the cost of production can be further materially lessened.) *Engineering and Mining Journal*, Feb. 4.

"Electric Smelting and Casting." (Details of the Taussig system of smelting and casting metals in exhausted chambers, wherein 1,000 cwt. of finished cast metal is obtained every fifteen minutes with an expenditure of 360 cwt. of coal, and with currents of 3,000 ampères and 2½ volts.) London *Electrical Engineer*, March 17.

"Ruthenium." Reference to ingot of ruthenium weighing 4½ pounds, prepared by M. Joly, with dynamo currents. London *Electrical Engineer*, March 10.

"Diamond Making By Electricity." (Abstract of communication to the Académie des Sciences on the production of varieties of carbon, amorphous carbon graphite and diamond, by M. Henri Moissan. A few of the experiments have yielded very small transparent crystals, and "the artificial production of diamonds has therefore been accomplished.") London *Electrical Engineer*, March 10.

"The German Elmore Works." By Clarence P. Feldmann. (Illustrated description of the Ellmore's metall aktiengesellschaft, at Schladern, forty miles from Cologne.) London *Electrician*, March 10.

ELECTRO-PHYSICS.

"Separation and Striation of Rarefied Gases under the Influence of the Electric Discharge." (Abstract of a communication by Mr. E. C. Baly before the Physical Society, and discussion.) London *Electrician*, Feb. 17.

"Electrical Phenomena." By Lord Armstrong. (Lecture delivered before the Literary and Philosophical Society of Newcastle-on-Tyne, with numerous experiments.) London *Electrical Engineer*, Feb. 10.

"The Colors of Cloudy Condensation." By Prof. Carl Barus. (Including experiments relating to electrification, etc.) *American Meteorological Journal*, March.

"Glowing of Disconnected Incandescent Lamps." By N. S. Amstutz. *Electricity*, March 1.

"Experiments of M. M. Sarasin and De La Rive on Electrical Oscillations." (With illustration from *La Nature*.) *Electrical Engineer*, Feb. 22.

"Electrical Oscillations of High Frequency." By Ervin S. Ferry. Part III — The energy of the field produced by the exciter; Reflection of electrical waves in the air; Interference; Multiple resonance; Recent improvements in detectors of electrical oscillations. Part IV — Propagation in wires; Velocity of propagation of electrical oscillations; Reflection; Refraction; Polarization; Conclusion. *Electrical World*, March 4 and 18.

"Attraction of a Hemispherical Shell on a Unit Quantity of Matter at Its Center." By Prof. S. T. Moreland. (Contends that statements on page 168, Daniell's "Text Book of Physics," and page 119, Barker's "Physics," are not correct.) *Electrical Review*, March 18.

"A Curious Action of Attraction by Alternating Currents." By Elihu Thomson. (A noteworthy case of apparent attraction of closed circuits in the neighborhood of an alternating magnetic pole.) *Electrical Engineer*, March 15.

"Experiments with High Frequency Electric Discharges." By A. A. C. Swinton. (See *Electrical Engineer*, Jan. 25, a reply to Nikola Tesla's reply in the *Electrical Engineer*, Feb. 1, entitled "The Physiological and Other Effects of High Frequency Currents.") *Electrical Engineer*, March 22.

"On the Current Strength in Simple Circuits Containing Resistance and Inductance Under Periodic Impressed Electro-Motive Forces of the Rectangular Wave Type." By A. E. Kennelly. *Electrical World*, March 18.

"The Tesla Lecture in St. Louis." (Abstract of lecture, with portrait of Nikola Tesla.) *Electrical Engineer*, March 8.

"The Rotating Electric Field and the Rotations Due to Electrostatic Hysteresis." By Riccardo Arnó. (Details of experiments with diagrams of circuits that may be used to show in an experimental way the phenomenon of electrostatic hysteresis in dielectric bodies, and to make evident the existence of the difference of phase which can be obtained from two alternating differences of potential of equal period." London *Electrician*, March 3.

"M. Janet's Experiments with High Frequency Currents." (Reprint from *La Lumière Electrique*, showing M. Janet's repetition of Elihu Thomson's experiments; and editor's footnote. *Electrical Engineer*, March 22.

"Lighting by Phosphorescent Tubes." (Details of inductor dynamo and phosphorescent tubes manufactured by Pyke and Harris, for vacuum-tube entertainments.) London *Electrical Engineer*, March 10.

"Sound and Vibration." (Discussion at the Royal Institution, by Lord Rayleigh, of some of the fundamental questions of acoustics.) London *Electrical Review*, March 10.

"Oscillographs for the Investigation of Slow Electric Oscillations." By A. Blondel. Reprint from the Comptes Rendus, Vol. CXVI, No. 10, March 6, describing some new galvanometric apparatus for determining by direct observation the periodic curves of alternating currents.) London *Electrician*, March 17.

ELECTRO-THERAPEUTICS.

"The Action of Ozone on Bacteria." By J. C. Dittrich. *Electrical Review*, March 4.

"The Press and Electro-medical Remedies." (An editorial appeal to the general press to prevent the public from being misled by the statements of electrical quacks and fakirs regarding the curative properties of their nostrums and devices.) London *Electrical Review*, March 17.

ENGINES.

"Economy of a Non-Condensing Compound Engine." By Prof. R. C. Carpenter, Sibley College, Cornell University. (Test report of a tandem compound engine built by Clarke Brothers; with comparative data.) *Cassier's Magazine*, February.

"The De Laval Steam Turbine." (Illustrating the steam turbine invented by Dr. de Laval, of Stockholm, and in use in the electric lighting plant in Falun, Sweden.) London *Industries*, Feb. 17.

"The Cost of Steam Power Produced with Engines of Different Types Under Practical Conditions; with Supplement Relating to Water Power." By Charles E. Emery, Ph.D. (A paper read before the American Institute, March 21, and containing elaborate tables showing cost of steam power under varying conditions.) *Transactions* of the American Institute Electrical Engineers, March.

"Practical Notes on the Steam Jacket." By W. Fletcher. (Advocating and explaining the advantages following the steam jacketing of cylinders.) *Cassier's Magazine*, March.

"Modern Gas and Oil Engines." By Albert Spies. (First Paper—Illustrating and describing the Otto, Fielding, Day and Griffin engines.) *Cassier's Magazine*, March.

ENGRAVING.

"Engraving by Electricity on Glass." "The heated platinum point chipping the glass, and as the tool is lifted fine fibers of glass are drawn out." The *American Art Printer*, March.

ETHICS.

"Electrical Engineering and Courtesy." By Sidney F. Walker. (A plea for courteous consideration in discussing electrical questions either at the Institute or in the journals.) London *Electrical Review*, March 17.

GAS LIGHTING.

"Electric Light and Gas." By E. C. De Segundo. (Comparative data showing cost of gas and of electricity under given conditions.) London *Electrical Review*, Jan. 27, Feb. 10 and 17.

"Comparative Cost of Gas and Electricity." (Brief abstract of J. M. Turnbull's paper, wherein it is shown that electric lighting is three times more expensive than gas in Edinburgh.) London *Electrician*, March 3.

"Gas and Electricity." By G. Emil Hesse. (Maintains that the great loss that occurs when the energy stored in gas is changed to light may be avoided by using the gas in engines to drive dynamos, the engine consuming 112 candle-power in gas per actual horse-power hour, and giving 193 candle-power per hour in incandescent lights, a gain of seventy-one per cent.) *Electricity*, March 8.

"Dangers from Gas in Electrically Lighted Cities." By M. P. Jousselin. (Abstract of a paper presented before the Society of Civil Engineers, Paris, describing accidents resulting from the perforation of gas pipes by electric currents from neighboring conductors.) *Western Electrician*, March 4.

HEATING, ELECTRIC.

"Giraud's Thermo-Electric Stove." (Illustrated description from *La Lumière Electrique*, Feb. 4.) London *Electricity*, Feb. 17.

"Moissan Electric Furnace." (Details of remarkable results obtained by M. Henri Moissan.) London *Electrician*, March 3.

"The Electric Furnace." (Editorial comment on the successful reduction of metallic chromium in Moissan's furnace.) London *Electrician*, March 3.

"Electric Heating." (Editorial comment on the desirability of heating and cooking by electricity, and to its uses in the arts, a temperature

of 5,368° Fahr. having been attained.) *Heating and Ventilation.* March 15.

HISTORICAL.

(See Biographical.)

(See Dynamo Electric Machinery.)

(See Electric Progress.)

(See Railways, Electric.)

(See Lighting Plants, Isolated.)

(See Central Stations. Electrical Features of St. Louis.)

"Theory and Practice in Electrical Science." By Alexander Siemens. (Abstract of Friday evening discourse delivered at the Royal Institution, Feb. 3.) London *Electrician*, Feb. 10.

"Who Really Invented the Lightning Rod?" (Editorial comment on the absence from the Electricity building of the name of Procopius Diwisch, a Bohemian catholic priest and professor of philosophy at the Lyceum of Luka, whom Joseph J. Král claims erected the first lightning rod in 1754.) *Electrical Review*, Feb. 10.

"An Historic Edison Plant." (Details of installation on the S. S. Colombia in May, 1880.) *Electrical Engineer*, March 1.

INSULATION.

(See Central Station.)

"The Inventor of Gutta-Percha Covered Wire." Letter from Mr. F. H. Danchell, a Danish engineer, claiming to have insulated wire with gutta-percha about 1845, and reply from Alexander Siemens. Reprint from *Engineer*. London *Electrical Review*, Feb. 3.

"Insulated Electric Conductors." By Dr. James B. Williams. Part XIX. *Electrical Engineer*, March 1.

"Conductors and Insulators." By Reginald R. Fessenden. (Giving a brief account of the theory of conduction, and then following with details of the practical use of substances as conductors and insulators.) *Electrical World*, March 4, 18, 25.

"The Theory of Dielectrics." By A. Hess. (Abstract of a paper read before the Société Française de Physique.) London *Electrician*, March 3.

"The History of Liquid Insulators." By A. M. Tanner. (From 1858 to present time.) London *Electrical Review*, March 3.

INDUCTION.

(See Telephone.)

INSURANCE.

"Relation of Insurance to Electric Lighting and Power." By Capt. William Brophy. (A paper read before the National Electric Light Association, at St. Louis.) *Electrical Review*, March 11.

"Electric Stations as Insurance Risks." By George P. Low. *Street Railway Gazette*, March 18, 25.

LAMPS, ARC.

"The 'Incandescent Arc' Lamp as a Rival to the Incandescent Lamp." By Augustus Noll. (Estimates for lighting interiors under different conditions showing marked difference in favor of the arc, and also giving details of some street lighting.) *Electrical Engineer*, March 22.

LAMPS, INCANDESCENT.

"The Incandescent Lamp from a Commercial Standpoint." By Calvert Townley. A paper read before the National Electric Light Association, describing the super-treated burners in the new Westinghouse lamp, with curves, etc., with Mr. Howell's important remarks regarding the life of lamps.) *Electrical Review*, March 11.

"The Incandescent Lamp Situation." (Letter from Franklin S. Terry, manager of the Ansonia Electric Company, suggesting suitable subjects for editorials on the lamp question, and comments of prominent manufacturers and central station men on Terry's letter.) *Electrical World*, March 25.

"The Most Economical Age of Incandescent Lamps." By Carl Hering. (Report of discussion of Mr. Hering's paper containing valuable data for producers and consumers of lamps.) *Transactions* of the American Institute of Electrical Engineers, March.

"The Incandescent Lamp from a Commercial Standpoint." Extended remarks in regard to the history of the progress of incandescent lamp manufacture and the essential qualifications for a lamp of long life and high efficiency, by Prof. Edward Weston, while discussing Mr. Townley's paper at the St. Louis meeting of the National Electric Light Association. "I take it that the present paper is the outcome of the existing situation. One has the old lamp to sell, the other has a new lamp to introduce. A new lamp did I say? The glass stopper lamp is not new; the iron wires are not new; the carbon is not new. The absence of the information asked for in regard to what is meant by 'super-treated burner' makes me hesitate to say that that is not new, but I think it improbable that those engaged in the use and experimental investigation of the hydro-carbon process left anything to be done in the way of extra treatment in that direction." *Electricity*, March 22.

"Electric Lighting." By Nelson W. Perry. (Detailing the plan of arc and of incandescent lighting and the production of current under varying conditions, etc. A popular article.) *The Independent*, March 2.

LIGHTHOUSES.

(See Signals, Electric.)

"Lighthouse Illuminants." (Abstract of article in the Liverpool *Journal of Commerce* in which the statement is made that "there is a

consensus of opinion among masters, pilots, and officers that the electric light is not suitable for the illumination of coasts," and that the commissioners should be allowed to foster the application of gas.) London *Electrical Review*, March 3.

LIGHTNING.

(See Historical.)

"Lightning Photography." By W. N. Jennings. (With four excellent photographs secured from a moving train in North Dakota.) *Electricity*, March 1.

"Multiple Images in Lightning Photographs." By Elihu Thomson. (Suggesting that the multiple images in Jennings' photographs were formed by the movement of the camera tube occurring between the times of the successive flashes down the same path.) *Electricity*, March 15.

"Notes on Lightning Protection." By A. J. Wurts. (Extended remarks on "the leads to and from the arrester; the ground connection, and the nodal points.) *Electrical Engineer*, March 15.

MAGNETISM.

"Magnetic Properties of Substances at Various Temperatures." By P. Curie. (Abstract from the *Comptes Rendus*, Jan. 23, Vol. CXVI, No. 4.) London *Electrician*, Feb. 17.

MAIL CARRIERS, ELECTRIC.

"The Electric Railway Mail Service at St. Louis." By Postmaster John B. Harlow. (Complete description of the plan of operation.) *Electrical Review*, March 4.

METERS, ELECTRIC.

"Price Current Meter." (Illustrated description of W. G. Price's invention for determining the velocity of the flow in Niagara River.) *Engineering News*, March 2.

"A method of Calibrating Ammeters and Voltmeters at Central Stations." (Abstract of paper read by Messrs. Brew and Ledger.) *Electrical World*, March 4.

"Suggestions for Metering Devices." By S. D. Mott. *Electrical World*, March 4 and 25.

MINING, ELECTRIC.

"Fourth Annual Report of the Inspector of Mines of the State of Montana." From Joseph Hogan, Inspector, Helena.

"Electricity in Mining." By William L. Saunders. (Refers to several installations as efficient, but believes that compressed air affords the simplest means for operating light machinery underground, and suggests the use of electric air compressors, and the use of electricity in lighting and haulage and heavy power.) The *Independent*, March 2.

MUNICIPAL LIGHTING.

"Municipal Contracts." By Alfred H. Gibbings. (Advising municipal authorities to employ a competent electrical engineer to contract for city lighting, rather than have so important an undertaking settled by a council committee.) London *Electrical Review*, Feb. 10.

"The Cost of An Alternate-Current Supply." (Table and figures giving cost and expenses and receipts per unit of supply from the Cologne central station, showing profitable transactions.) London *Electrician*, March 3.

"Electric Lighting Schemes for Strassburg." (Abstract of elaborate report of Oscar Von Miller, of Munich, on the establishment of a central electric lighting station in Strassburg, to be operated by engines and also by turbines.) London *Electrical Engineer*, March 3.

The Proposed Municipal Electric Lighting Scheme for Burton-on-Trent. By H. Waring. (Details of construction.) London *Electrical Engineer*, March 17.

"Ealing Electric Lighting." (Abstract of report from Messrs. Bramwell and Harris on the proposed electric lighting of the Ealing district.) London *Electrical Review*, March 10.

"The Electric Lighting of Belfast." (Abstract of an elaborate report furnished to the Belfast city council by Prof. Alexander B. W. Kennedy, F.R.S., regarding the proposed electric lighting of the city.) London *Electrical Review*, March 10.

"Titusville Municipal Plant." (Comptroller's statements showing that lights cost city $6.93 per month per light, and local company offers to supply at $6 per light per month.) *Electrical Engineer*, March 29.

"Street Lighting by Private Versus Municipal Plants." By Horatio A. Foster. (Reduces to a lamp hour basis the figures presented by R. J. Finley in *Review of Reviews*, thus affording comparison from a common unit.) *Electrical Engineer*, March 29.

"Joint Debate." "Question: Would municipal ownership and operation of lighting works and street railroad lines be preferable to private ownership and operation in cities of the United States of 25,000 or more inhabitants? It being conceded that the change of ownership can be legally made." "Interpretation: 1. 'Municipal operation' to mean direct and absolute management by the cities themselves through their officials. 2. 'Lighting works' to mean gasworks and electric light systems. 3. 'Street railroad lines' to include all those means of transportation on rails which are organized exclusively for urban and suburban traffic." A joint debate between Affirmative—Athenæ: H. E. Page, E. R. Stevens, J. M. Johnston. Negative—Philomathia: J. A. Pratt, J. B. Pollock, J. E. Webster, at the University of Wisconsin; the judges being Hon. Neil Brown, Rev. E. G. Updike and President C. K. Adams; and the decision being in favor of the affirmative. The *Aegis*, Madison, March 3.

OVERHEAD LINES.

(See Wiring Tables.)

"The Vulcanizing Process for Preserving and Strengthening Poles, Cross Arms, Ties, Etc." (A paper read before the National Electric Light Association at St. Louis, presenting data showing that the life and strength as well as the electrical resistance of wood is increased about eighteen per cent by the vulcanizing process.) *Electrical Review*, March 11.

"Poles." By G. A. Nall. (Data regarding life and cost of poles and cross arms.) *Electrical Age*, March 25.

PATENTS.

"Our Patent System." By Arthur Steuart. (A discussion of some of the fundamental principles involved in the patent systems of this and other countries. Also, remarks on the "effect upon the minds of a people of a system of monopolies as distinguished from a recognition of intellectual property," with remarks on the "misconception of the nature of intellectual property by some of the judges of later times." *Electrical Review*, March 25.

"Review of Electrical Patents." *World's Fair Electrical Engineering*, January, February, March and April.

"Unjust Law." By A. B. Upham. (Commenting on the absurdities in the law of limiting the U. S. patent by the prior foreign one.) *Electrical World*, March 25.

POWER TRANSMISSION.

"Remarks Concerning Power Transmission from the Economic Standpoint." By L. B. Stillwell. (A paper read at the St. Louis meeting of the National Electric Light Association, and covering the capitalist's side of the question from the standpoint of a profitable, practicable investment.) *Electrical Review*, March 11.

"Power Transmission for Central Stations." By Dr. Louis Bell. (A paper read at the St. Louis meeting of the National Electric Light Association, giving general conditions under which distribution may be satisfactorily accomplished.) *Electrical Engineer*, March 11.

"Electrical Power Transmission from Tivoli." (Description of plant operated by waterfall (360 feet) for transmission to Rome, Italy, 17 miles distant. Ganz 30-pole alternators of 5,100 volts and 42 ampères are turbine driven at 170 revolutions, and 100 tons of copper constitutes the leads, in which there is a loss of 20 per cent at full load.) London *Industries*, March 17.

"Bovet Magnetic Adhesion Apparatus." By R. V. Picou. (Reprint from *L'Industrie Électrique*. Illustrated description of the Bovet magnetic pulley for chain towing, the Bovet magnetic clutch and the Bovet magnetic railway brake.) London *Electrician*, March 3; *Street Railway Gazette*, March 18.

"Electricity as a Motive Power." By Albion T. Snell. (A series of papers on the general scheme of electrical transmission of power, including the "prime source of power," "the dynamo," "the line," "the motor," "the driven machines," etc.) London *Electrician*, March 17.

"The Development and Transmission of Power from Central Stations." By Prof. W. Cawthorne Unwin, F.R.S. (Six Howard lectures, delivered before the Society of Arts. Third lecture includes data relative to water-power storage; teledynamic transmission; teledynamic installations; and comparisons. Fourth lecture, systems of hydraulic transmission, accumulator versus reservoir storage; London and Geneva systems compared. Fifth lecture, advantages of compressed air and details of systems. Sixth lecture, distribution of power by steam, gas and electricity, and reference to the future of power distribution.) London *Electrician*, Feb. 3, 10, 17, 24.

"Power Transmission by Electric Motors in Fraser & Chalmers' Plant." *Electrical Industries*, March.

"Long Distance Transmission of Power By Direct Currents." By Frank Kitton. (Abstract of a talk and discussion before the Buffalo Electrical Society, with data regarding the Genoa plant.) *Electricity*, March 22.

"Water-Power Utilization." By W. H. Booth. (A practical article treating on the different forms of turbines, and giving reference data.) London *Electricity*, Feb. 24, March 10 and 17.

"Electrical Transmission of Power for Mills." By Prof. C. J. H. Woodbury. (A paper read before the New England Cotton Manufacturers' Association, and containing data of power installations now in New England mills.) *Cassier's Magazine*, February.

"Electric Power from Niagara Falls." Interview with Prof. George Forbes. *Electrical Review*, Feb. 25.

"The Discharge of the Niagara River." (Abstract of the report of Mr. J. C. Quintus, of the U. S. Engineer Corps, with tables, curves, etc.) *Engineering News*, March 2.

"The Niagara Turbines." By Clemens Herschel. (Complete illustrated description of system employed, with full details of construction.) *Cassier's Magazine*, March.

"The Future City of Niagara Falls." (Brief reference to area covered by Niagara Falls Power Company, and view of harbor and intake works and of the great hydraulic tunnel.) *Electrical Engineer*, March 29.

"A Convertible System of Arc Lighting and Constant Potential Power Service." By S. W. Rushmore. (Details of the Rushmore patented system.) *Electrical Engineer*, March 29.

PROGRESS, ELECTRICAL.

"One Year of Electricity." (Abstract of articles appearing in its pages during the year, with portraits of Stephen D. Field, Rudolf

Eickemeyer, Prof. Graham Bell, George D. Seely, Gustav Bissing, Cyrus West Field, Charles J. Van Depoele, Marmaduke M. M. Slattery, etc.) *Electrical Review*, Feb. 25.

"Electrical Development in Japan in 1892." By S. Katogi. (Total length telegraph lines, 25,472 miles, 546 offices, 1,598 operators. At Tokyo, 1,299 telephone subscribers; at Yokohama, 254 subscribers. Increase in incandescent lamps in Tokyo, 4,300.) *Electrical Age*, March 28.

"The Future of Electricity." By Park Benjamin. (An interesting popular article pointing out the probable source of supply of electricity in the near future as a cell directly consuming carbon by cool chemical combination with oxygen, and dilating on the probabilities in electrical applications.) The *Independent*, March 2.

RAILWAYS, ELECTRIC.

"Facts Concerning the Siemens Electric Railway of 1879." By A. M. Tanner. (Quoting extracts from the Berlin *National Zeitung*, of June 8, 1879, and the *Archiv für Post und Telegraphie*, of July, 1879; and concluding that "Werner Siemens must always be considered as having proposed and constructed the first electric railway which actually conveyed passengers," "80,924 persons having been carried in 119 days on the Berlin electric railway in 1879.") London *Electrical Review*, Feb. 24.

"The $350,000 Cable Road and the $46,000 Electric Road.—V." (Detailed estimates of cost, etc., continued from December.) *Street Railway Journal*, March.

"Two English Electric Railways." (Details of receipts and operating expenses of the City & South London and the Liverpool overhead railway lines.) *Engineering News*, March 9.

"The Tendency of Population into Cities." (Elaborate review of census bulletin No. 165, with tables.) *Engineering News*, March 9.

"Legislation for the Electric Railway." (Abstract from the annual report of the Board of Railroad Commissioners of Massachusetts.) *Street Railway Gazette*, March 4.

"What a Four-Cent Fare Means." (Editorial.) *Street Railway Gazette*, March 4.

"The Freight Business of Street Railways." (Editorial.) *Street Railway Gazette*, March 4.

"The Rights of the Investor." (Editorial comment of the plea of President Henry M. Whitney before the Rapid Transit Committee of the Massachusetts Legislature.) *Street Railway Gazette*, March 4.

"Electrical Railways." By Dr. Edward Hopkinson. (Abstract of paper read before the Institution of Civil Engineers, giving full details of the electrical plant of the City & South London railway plant, with editorial review.) London *Electrical Engineer*, Feb. 17.

"The Possibilities of Railway Speed." By George Westinghouse, in the New York *Commercial Advertiser*. *Electrical Review*, Feb. 25.

"Long Electric Railroads in Ohio." (Reprint from the New York *Evening Post.*) *Electrical Engineer*, Feb. 22.

"Electric Freighting at Thomaston, Me." *Electrical Engineer*, March 1.

"Will the Closed Conduit Supersede the Trolley in Large Cities." By Frank C. Perkins. (Paper read before the Buffalo Electrical Society, March 6, giving details of various conduit systems and referring to the Perkins' system.) *Street Railway Gazette*, March 18.

"The Possibilities of High-Speed Electric Traction." By Frank B. Lea. (A paper read before the Owens College Engineering Society, March 14, and detailing present practice in high-speed steam and electric traction.) London *Electrical Engineer*, March 17.

"Electric Traction and Gearing." (Illustrated description of Beaumont's single reduction variable speed gear and Beaumont's direct-driving variable speed gear.") London *Electrical Engineer*, March 17.

"Maximum Average Speed and Capacity of Rapid Transit Trains." (With diagrams and table giving the results of an analysis of speed-recorder diagrams taken from trains running on a rapid schedule on elevated road.) *Street Railway Gazette*, March 18, 25.

"Electric Traction in 1850." (Details of patent granted to Dr. John H. Lillie, with portrait.) *Street Railway Review*, March.

"Operating Expenses." (Statement showing earnings and operating expenses with detailed distribution.) *Street Railway Review*, March.

"Designs for a Suburban Railway Power Plant." (*Electrical Engineer*, March 29.

"Rail Bonding and the Ground Return." (Brief history of methods, present difficulties, and reports from leading roads throughout the country, with resistance tests, remarks on water-pipe connections, and on the comparative conductivity of rails and bonds.) *Street Railway Review*, February and March.

RAILWAY PLANTS, ELECTRIC.

"The Electric Railway to the Saleve, near Geneva." London *Electricity*, Feb. 17.

"Denver and Its Street Railways." (A very complete description of the street railway systems of Denver, Colorado, covering 20 pages and having 45 handsome illustrations.) *Street Railway Journal*, March.

"Woodland Avenue and West Side Street Railway, Cleveland." *Street Railway Journal*, March.

"West Side Electric Railway, Elmira, N. Y." *Street Railway Journal*, March.

"Sioux City, Iowa." By C. B. Fairchild. (Complete description of the street railway system.) *Street Railway Journal*, March.

"The Electric Roads of Chicago." (And editorial.) *Street Railway Journal*, March.

"Benton-Bellefontaine Street Railway, St. Louis." *Street Railway Journal*, March.

"The Calumet Electric Railway, Chicago." *Street Railway Gazette*, Feb. 27.

"The Los Angeles Street Railways." *Street Railway Gazette*, Feb. 27.

"Racine's Street Railway." *Street Railway Review*, March.

"South Chicago Electric Railway." *Street Railway Review*, March.

"Fort Wayne's Electric System." *Street Railway Review*, March.

"Electric Traction in the City of Philadelphia." By R. L. Warner. (I — The City vs. the Trolley. II — Line and Track Construction. III — Power Station and Car shed. IV — The Steam Plant. V — Electrical Equipment.) *Electrical Engineer*, March 22.

"Electric Railways." By William W. Share, Ph.D. (A popular explanation of work accomplished in the line of electric traction.) The *Independent*, March 2.

STANDARDS AND MEASUREMENTS.

(See Electro-Chemistry.)

"Electrical Measurements." By Prof. George D. Shepardson. (A practical, comparative and descriptive article, with illustrations of instruments used.) *Street Railway Review*, February and March.

"A Null Method of Measuring Specific Inductive Capacity of Conducting Liquids." By F. Heerwagen. (The method consists in the use of a differential electrometer, which is so constructed that two electrometer needles are fixed to a common axle and hang in quadrant pairs over one another. Abstract from *Wiedemann's Annalen* No. 1, 1893. London *Electrician*, March 17.

"Practical Instruments for the Measurement of Electricity — XII." By J. T. Niblett and J. T. Ewen, B.Sc. (Describing Muirhead's improved slide resistances.) London *Electrical Engineer*, March 3.

"Temperature Coefficient of Mercury." By Kreichgauer and Jaeger. Abstract of a series of elaborate and careful researches on this point from results published in full in Wiedemann's *Annalen* No. 12, 1892. London *Electrician*, March 17.

SIGNALS, ELECTRIC.

"Electrical Block Interlocking Systems." (Abstract of paper read by Mr. R. Woods, before the Derby (England) Society of Engineers; and discussion.) *Industries*, Feb. 17.

"Electrical Communication with Lighthouses." (Abstract of first report of the royal commission, showing cost of telephone connections, etc.) London *Electrician*, Feb. 3.

"Electric Balloon Signaling." (Abstract of paper read by Mr. Eric Stuart Bruce before the Royal United Service Institution.) London *Electrical Review*, Feb. 3.

"Electric Lights for Railway Signals." By Samuel Sherman. *Electrical Industries*, March.

"A Simple System for Operating Electric Clocks." By R. G. Brown. *Electrical Engineer*, Feb. 22.

"Electric Side-Lights on Ships." (Abstract of Board of Trade Departmental Papers, No. 176, discussing the use of powerful glow lamps in the red and green side-lights in ships, and suggesting the use of darker slides than for oil lamps.) London *Electrician*, March 10.

SUBWAYS.

"The Durability of Underground Wires." By Herbert Laws Webb. (Affirming that underground electrical construction has become established and suggesting a free interchange of views and opinions based on practical experience.) *Electrical Review*, Feb. 25.

"Ice in the Subway." (Illustrated description of method of melting ice in subway by means of hot air forced by hand-worked bellows through iron piping.) *Scientific American*, March 11.

"Underground Conduits and Conductors and the Experiences of Electric Lighting Companies in New York City." By W. H. Browne. (A very complete and detailed description of the work of placing conductors underground accomplished under stress of circumstances.) *Electrical Review*, March 11.

TELEGRAPH.

"The Simplification of the Quadruplex, and the Importance of Its Achievement." By D. H. Keeley. (A paper read before the Canadian Society of Civil Engineers.) London *Electrician*, Feb. 3.

"Notes on Submarine Cable Work." By H. D. Wilkinson. Sections 27, 28 and 29. London *Electrician*, Feb. 17.

"The Latest Telegraph Statistics." From *Journal Télégraphique*, Jan. 25. London *Electricity*, Feb. 17.

The Chin Column Telegraph Expedition. By F. E. Dempster, superintendent of the Burma Division of Indian Government Telegraphs, Rangoon. (Detailing experience of expedition sent out in 1889 by the government of India, requiring temporary field lines.) London *Electrical Review*, Feb. 17.

"Universal Telegraphic Hour." Signor César Tondini de Quarenghi pleads for the establishment of a universal hour for telegraphic purposes over the world in the *Journal Télégraphique*. The initiative was taken in 1872 by the Turkish government for a proposal to count the hours 1 to 24 for all telegraphic work from a fixed meridian. Brief abstract in London *Electrical Engineer*, March 10.

"The Telautograph." Description of Dr. Elisha Gray's telautograph with diagrams of receiving and sending instruments and specimens of messages sent and received. Also, portrait and biographical notice of Doctor Gray, and editorial comment.) *Electrical World*, March 25.

"Earth Currents." By W. Finn. (Reference to abnormal currents of natural electricity on telegraph wires, March 17.) *Electrical Engineer*, March 29.

"The Telegraph." By A. B. Chandler, president Postal Telegraph Company. (Detailing the rise and growth of the electric telegraph in America.) The *Independent*, March 2.

"The Ocean Cable." By George G. Ward, vice-president and general manager Commercial Cable Company. (Detailing for popular perusal the manufacture, shipment, laying and operation of submarine cables.) The *Independent*, March 2.

TELEPHONE.

(See Telegraph.)

"The Telephone Situation." *Electrical World*, March 4, March 18.

"Induction at Great Distances Through the Air and Water Without the Use of Parallel Wires." (Abstract of a paper read by Mr. C. A. Stevenson, before the Royal Society of Edinburgh, explaining details of experiments undertaken to prove that a vessel passing over a cable could locate its position by the use of an indicator operated by induction.) London *Electrical Review*, Feb. 10.

"The Latest Telephone Statistics." From *Journal Télégraphique*, Jan. 25. London *Electricity*, Feb. 17.

"Telephoning by Induction." By G. H. Bryan. (Note commenting on newspapers' scientific notes.) *Science*, March 3.

"The Telephone." By Grosvenor P. Lowrey. (Review of the legal history and commercial aspects of the telephone question.) *Electrical Review*, Feb. 25.

"Detroit Talks to New York, Chicago and Pittsburgh." (Illustrated description of the opening of the long-distance telephone lines.) *Electrical Review*, March 4.

"Clamond's Microphone and the Berliner Transmitter." (A discussion of Clamond's general claims.) *Electrical Review*, March 4.

"Telephony." By Hammond Vinton Hayes. (An extremely interesting popular *résumé* of the present state of the art of telephony.) The *Independent*, March 2.

"The Practical Value of Long-Distance Telephony." By Herbert Laws Webb. (Illustrating the advantages offered for facilitating business transactions that could not be closed by telegraphic communication and which would otherwise require a journey.) *Engineering Magazine*, March.

"Government Suit to Annul the Berliner Telephone Patent." (With copy of claims and original drawings.) *Electrical Engineer*, Feb. 22, March 1.

WARFARE.

"Electricity and Our Coast Defences." By Charles L. Atwell. (First paper, illustrating torpedo exploded by electricity, exploding mines under water; and describing the mines and torpedoes in use.) *Cassier's Magazine*, March.

"Electricity as Applied to Warfare on Land and Sea." By Moses G. Farmer. (Details of the Lay, the Edison-Sims, and the Spar torpedoes, and reference to use of search lights.) The *Independent*, March 2.

WIRING TABLES.

"An Ampère Foot Table." By G. T. Evans. (Tables for calculating sizes, weights, etc., of line wires; with loss in volts, safe ampères open and encased, and circular mils tabulated; also, examples illustrating methods of using tables.) *Electrical Engineer*, March 15.

WIRING.

"Electric Installations and Some Radical Changes in General Systems of Wiring." By C. G. Armstrong. (A paper read before the Chicago Electric Club, February 20, and illustrated by means of lantern slides, and discussion. *Western Electrician*, March 18 and 25.

NEW PUBLICATIONS.

THE MEASUREMENTS OF ELECTRICAL CURRENTS AND OTHER ADVANCED PRIMERS OF ELECTRICITY. By Edwin J. Houston, A.M., New York. The W. J. Johnston Company, Limited, 41 Park row; 429 pages; 169 illustrations; 5 by 7; price $1.

An excellent work for non-technical visitors to the electrical section of the World's Fair to read, as it gives a concise, lucid description of the various methods adopted for supplying electricity, with illustrated descriptions of the generators. The younger students will also find much practical information condensed within its pages.

ALTERNATING CURRENTS: An Analytical and Graphical Treatment for Students and Engineers. By Dr. Frederick Bedell and Dr. Albert C. Crehore, New York. The W. J. Johnston Company, Limited; 325 pages; 112 illustrations; 6½ by 9½; price $2.50.

A clear and logical explanation from a broad standpoint of the problems presented in the study of the application of alternating currents in engineering work, and while a considerable portion of the contents has already appeared in technical publications, yet the handsome form in which it is here presented adds to the convenience and pleasure of a second reading. Mathematical terms are fully employed, but the conclusions reached are so graphically depicted that the subject may be followed by many without recourse to mathematics.

THE VOLTAIC CELL. By Park Benjamin, LL.B., Ph.D.; 562 pages; 6½ by 9½. New York: John Wiley & Sons. Price $5.

A work that ought to prove of practical value to many delvers after the bonanza that is supposed to be hidden within the cells of a primary battery. For in addition to the fund of general practical data contained within its pages there are descriptions of all the leading types of primary battery cells that have been brought out, with illustrations of many. Thus it is only necessary for a "primary battery enthusiast" to peruse its pages carefully to see how ancient and well ploughed over are the plans he deems so original and promising. The subject of "accumulators" or "storage" cells is also ably handled in the last 125 pages of this work, and several important tables of data are appended. And last, but by no means least in value, is a very complete "Bibliography of the Voltaic Cell," including books, papers and periodicals. A convenient index completes the work.

EXHIBITS RECEIVED UNTIL APRIL 30.

Director-General Davis issued the following general order April 11:

Notice is hereby given transportation companies and exhibitors in the World's Columbian Exposition that all exhibits for which permits for space have been issued and which can be delivered and placed in position and the exhibitor's work completed on or before April 30, 1893, will be admitted, and the regulation fixing April 10, 1893, as the last day on which exhibits will be received is hereby modified to that extent.

GEORGE R. DAVIS, *Director-General.*

THE INCANDESCENT LAMP SITUATION.—In a communication to "the editor of the *Electrical World*," Mr. Franklin S. Terry referred to the statement made by T. Carpenter Smith, at the St. Louis meeting, and suggested the following as suitable subjects for editorial comment, and offers "to supply some facts to assist in preparing them":

"1. Is it possible for the General Electric Company to obtain control of the lighting industry?

"2. Should the General Electric Company obtain control of the lighting industry, would the effect on the electric lighting business on the whole be beneficial or otherwise?"

The *Electrical World* sent copies of Mr. Terry's letter to several gentlemen prominent in the industry, and received several replies, one of which reads as follows, the writer's name not being given:

"My professional connection with this litigation about the incandescent lamp is such that it would not be proper for me to give formal expression to my private opinion on the questions propounded by Mr. Terry. I will say, however, that it is quite possible that the General Electric Company will be able for a time to get absolute control of the incandescent lamp business, for the chances are, of course, in favor of their success in the pending litigation with the western lamp manufacturers, and in that event they have only to make lamps fast enough to supply the market, and they will be secure from interference from the courts, probably until their Canada patent expires next year. But I do not see that this necessarily gives them control of the electric lighting industry, any more than it did in England. I do not think the control of the business by any one interest is likely to be beneficial to it, but that is merely my individual opinion. There are instances in which a monopoly has proved beneficial to the consumer, of which Standard oil is an example, but in a business so specialized, and involving such a vast number of diverse minor industries, I believe that many smaller concerns can produce the goods cheaper than a large one, while the stimulus of competition fosters invention and improvement, as well as economy of production. The trouble the General Electric Company will meet with in seeking to control all electrical industries is likely to be a financial one. If the central station men are pressed too hard, nothing will be easier for them than to start a coöperative manufactory.

"If the Edison Company had had at the outset the faith in their own patent to inforce it vigorously in the way that the Bell telephone people did, they might have been in as strong a position. But they contented themselves with windy proclamations, and did not do anything. This was a fatal mistake, and, in my opinion, it is too late to retrieve it."

World's Fair Electrical Engineering

THE FORMAL OPENING.

Electricity, as usual, played the leading part in the formal opening of the gates of the World's Columbian Exposition on the appointed first day of May.

There was no delay in the proceedings. On the Saturday preceding, Grover Cleveland, President of these United States, was received with royal welcome and escorted through the White City, expressing wonder and gratification at the marvelous work accomplished.

On Monday, May 1, standing on the raised platform in front of the Administration building, with the great area known as the Central Court filled with the representatives of all nations glad of the opportunity to listen to the words that fell from the lips of the chief magistrate of the nation, Mr. Cleveland commended the final outcome of the three years of ceaseless toil on the part of the Exposition officials, referred to the advantages that would accrue to the entire nation, not only in material prosperity but in the far more important sense of educational progression, and pressing a golden key instantly caused a hundred whistles to send outward their shrill cries, a thousand banners to be thrown to the breeze, and the wheels of the mammoth Corliss engine to slowly revolve till, attaining its normal speed, the whirr of moving machinery in all parts of the buildings was heard only for a moment and then to be drowned in the glad acclaim of the multitude as cheer after cheer was sent heavenward.

And Mr. Cleveland declared the Exposition open to all, complete in every essential detail, the wonder of the nineteenth century and a lasting honor to a city incorporated less than sixty years ago.

And over the world electricity flashed the news. Mr. Cleveland pressed the key at 12:09 P.M., standard time, and a moment

later the information was bulletined in New York and in San Francisco, and before the sound of the first signal was silenced, the fact was known in China and in London, served with the breakfast to our excluded brother and at the tea table on the Island.

President Cleveland spoke as follows :

"I am here to join my fellow-citizens in the congratulations which befit this occasion. Surrounded by the stupendous results of American enterprise and activity, and in view of magnificent evidences of American skill and intelligence, we need not fear that these congratulations will be exaggerated. We stand today in the presence of the oldest nations of the world and point to the great achievements we here exhibit, asking no allowance on the score of youth.

"The enthusiasm with which we contemplate our work intensifies the warmth of the greeting we extend to those who have come from foreign lands to illustrate with us the growth and progress of human endeavor in the direction of a higher civilization.

"We who believe that popular education and the stimulation of the best impulses of our citizens lead the way to realization of the proud national destiny which our faith promises, gladly welcome the opportunity here afforded us to see the results accomplished by efforts which have been exerted longer than ours in the field of man's improvement, while in appreciative return we exhibit the unparalleled advancement and wonderful accomplishments of a young nation and present the triumphs of a vigorous, self-reliant and independent people. We have built these splendid edifices, but we have also built the magnificent fabric of a popular government, whose grand proportions are seen throughout the world. We have made and have gathered together objects of use and beauty, the products of American skill and invention; we have also made men who rule themselves.

"It is an exalted mission in which we and our guests from other lands are engaged, as we coöperate in the inauguration of an enterprise devoted to human enlightenment; and in the undertaking we here enter upon we exemplify in the noblest sense the brotherhood of nations.

"Let us hold fast to the meaning that underlies this ceremony, and let us not lose the impressiveness of this moment. As by a touch the machinery that gives life to this vast Exposition is now set in motion, so at the same instant let our hopes and aspirations awaken forces which in all time to come shall influence the welfare, the dignity and the freedom of mankind."

THE ELECTRIC POWER CIRCUITS AT THE WORLD'S FAIR.

BY L. S. BOGGS, ENGINEER IN CHARGE OF ELECTRIC POWER.

In addition to the numerous circuits transmitting current for arc and incandescent lighting, so fully described in the earlier numbers of WORLD'S FAIR ELECTRICAL ENGINEERING, there is also an independent set of eight circuits designed for electric power service only. These circuits extend either directly or by means of tap-wires into all the principal buildings and have a total length of 95,000 feet, insulated with ⅛-inch wall of rubber, over-braided.

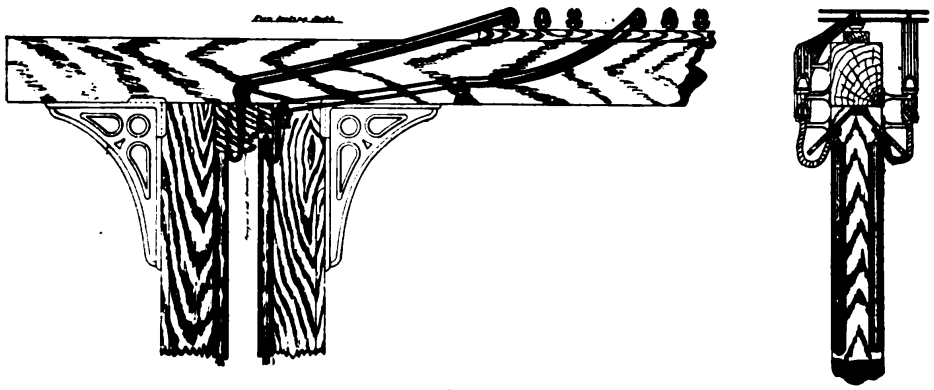


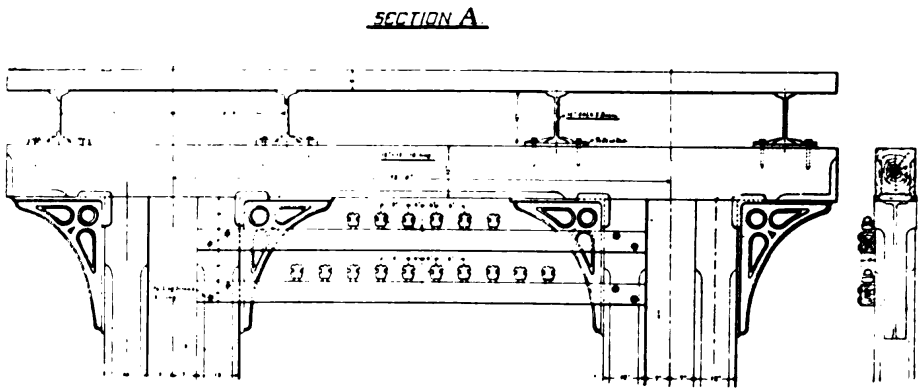
FIG. 1.

These circuits are numbered respectively from 1 to 8, and are distributed about the grounds in the following order, it being understood that the cables pass down into the subway from the respective blocks containing the generators, as fully described and illustrated in the January, February and April numbers of this magazine. Circuits Nos. 1 to 7 will convey current of 500 volts potential; circuit No. 8, current of 220 volts potential.

Circuit No. 1 supplies the necessary current for operating the motors in the Transportation building and the annex thereto, and consists of ten 0000 cables that pass down from the C. & C. generators into the subway, and from the northwest corner of the annex to Machinery hall are carried onto the elevated structure

(see Fig. No. 1) to the west center of the Transportation building, where a distribution of current, aggregating 200 horse-power for the Transportation building and an equal amount for the annex, is arranged for, making a total of 400 horse-power. Current may also be taken from these circuits not only for motor service, but also for so-called "incandescent arc lamps," operated in series of ten on these 500-volt circuits, to illuminate the interior of the annex to Transportation building.

Circuit No. 2, consisting of four 0000 cables, passes through the subway to the center of the Government building, where two of the cables are carried into the building to operate motors, 50 horse-power capacity of which are already placed, and the remaining two cables extended to the Fisheries building, to supply the



FIGS. 2 AND 3.

current required by two C. & C. motors that operate the circulating pumps connected to the tanks. Here the circuit is reduced to two 0 wires and carried up through tubing and attached to insulators supported on a series of special cross-arms fastened beneath the roadbed of the elevated railway structure, as shown in the accompanying illustrations (Figs. Nos. 2 and 3), and thereon passes around the north end of the park and as far south as the west center of the Woman's building. From the Woman's building a circuit of two 0000 wires extends south and east to the power plant, the two 0 wires being the connecting loop for the two arms of this circuit that has a total length of 28,930 feet. At the station of the Weather Bureau this circuit is tapped for current to operate a 5-horse-power motor; at the New York State building for a 25 horse-power C. & C. motor; at the Woman's building for

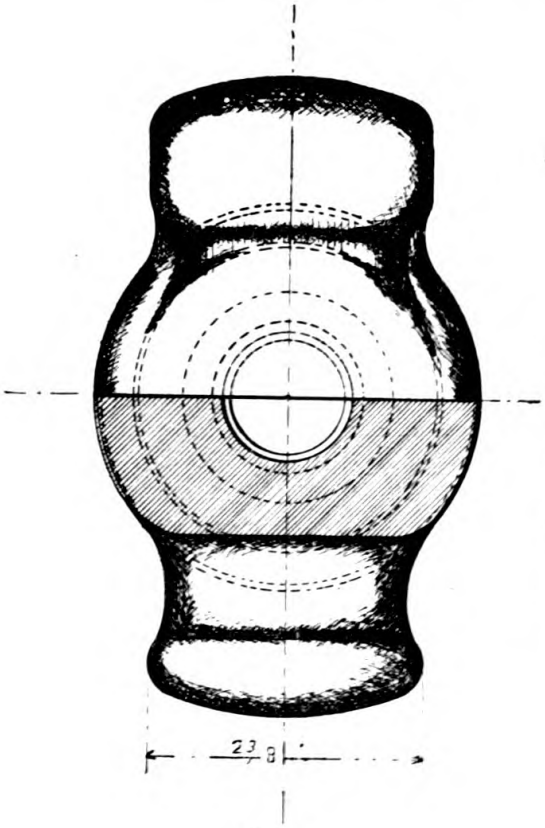


FIG. 4.

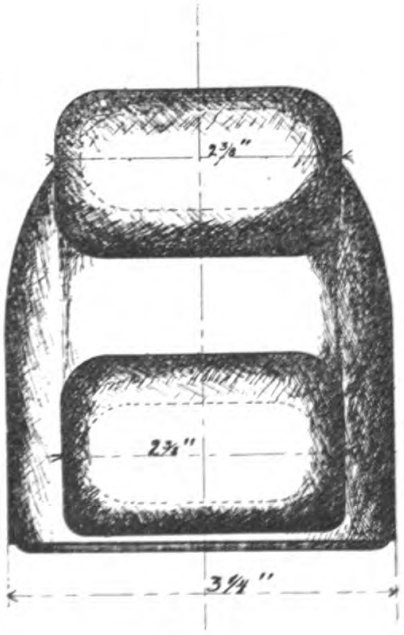


FIG. 5.

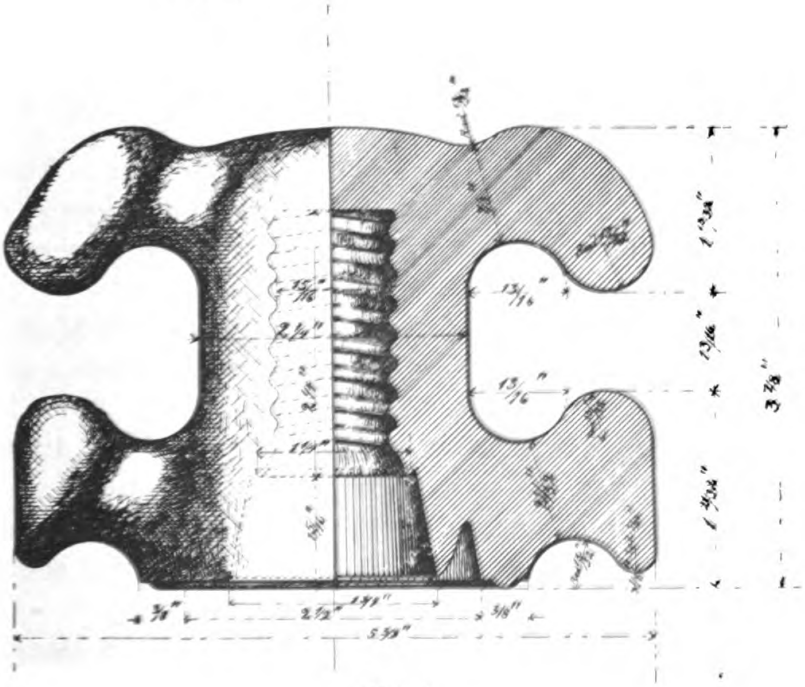


FIG. 6.

HEAVY TWO-WIRE GLASS INSULATOR.

two 20 horse-power motors for elevator service; at the northwest corner of the Horticultural building for a present aggregate capacity of 50 horse-power; and at the Service building for current to operate ventilating fan-motors of 3 horse-power and 5 horse-power capacity.

From the northwest corner of Machinery hall, power circuit No. 3, consisting of four 0000 wires, passes onto the elevated structure and is carried around to the east center of Midway Plaisance. Here it is divided into two circuits each of two 0000 wires and carried in the Plaisance on handsome octagonal poles that are

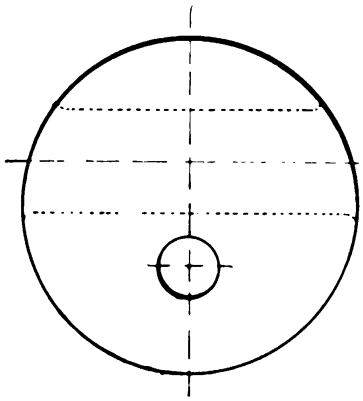


FIG. 7.
PORCELAIN INSULATOR.

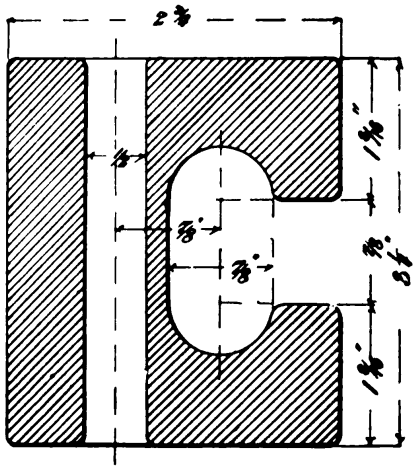


FIG. 8.

placed on each side of the Midway close to the fence. This circuit extends through the Plaisance and is tapped at frequent intervals to supply current to operate motors in this great foreign mart. The capacity of this circuit exceeds 200 horse-power.

Circuit No. 4, consisting of six 0000 cables, leaves Machinery hall at the southeast corner, and through ducts extends to and along the elevated structure to the east center of the Dairy building, where a 17½ horse-power motor is utilized in driving a refrigerating machine and a 30 horse-power motor belted to line-shafting. At the southwest corner of Agricultural annex a tap-line conveys current to six motors, one of 70, two of 60, and three of 30 horse-power each, that are driving line-shafting.

Circuit No. 5, consisting of six 0000 cables, leaves Machinery hall at the southeast corner and is supported beneath the elevated structure to a point near the southwest corner of the Agricultural

annex, then down through tubing and underneath the docking to the middle of the Casino pier, where it supplies the feeder-wires with 300 horse-power in current to the motors that operate the movable sidewalk described elsewhere in these pages.

Circuit No. 6, four 000 wires, conveys current to the Manufactures building, where an aggregate capacity of 150 horse-power in motors will be in service.

Circuit No. 7 supplies 400 horse-power in current to the Mines and Mining building, with the aid of six 0000 cables, operating two 150 horse-power motors belted to line-shafting, and one 6 horse-power and one 17½ horse-power motor connected to pumps, while additional motors are being attached.

Circuit No. 8 passes down from the C. & C. bus bars to the subway, and from thence in ducts to the southeast pavilion of the Administration building, and conveys 200 horse-power in current that is utilized in operating the eight 25 horse-power Eikemeyer elevator motors and the 42-inch ventilating fans, each of which are driven by a 2 horse-power motor.

A special form of heavy, double petticoated glass insulator (see Figs. Nos. 4, 5 and 6), designed to hold two wires, with separate tie wires, supports the power circuits on the cross-arms in subways and on the elevated structure, and the special form of porcelain insulator employed is shown in Figs. 7 and 8.

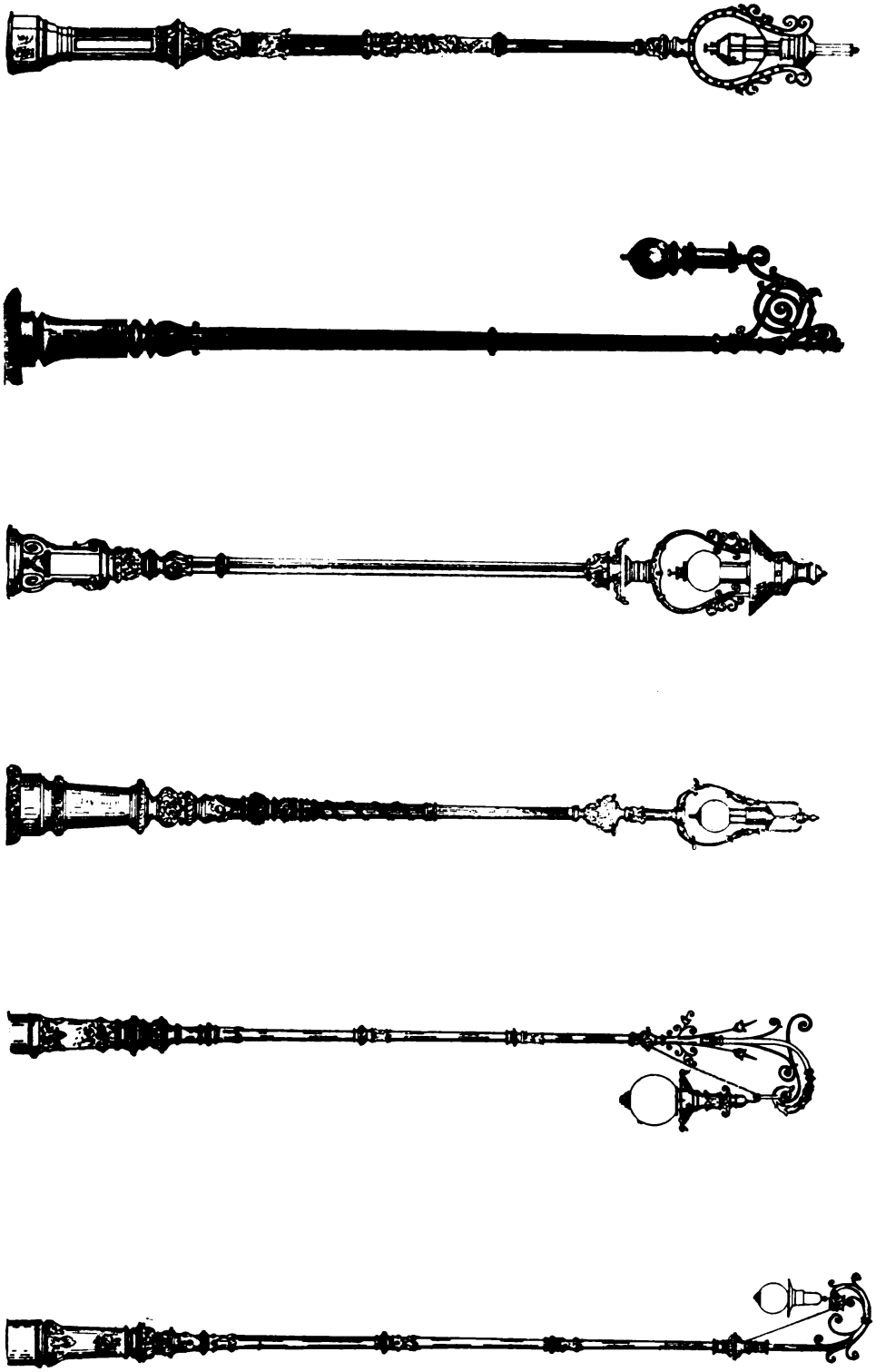
EXHIBITS IN THE ELECTRICITY BUILDING.

The activity that has prevailed at Jackson Park during the last thirty days is unequaled in history ; an energetic, hustling activity, not warlike but peaceful in nature, though, hero-like, the department chiefs and their staff lieutenants cheered on the laborers in the chilling winds and the raw rains that continued day after day, drizzling or pouring without cessation and often accompanied by winds of cyclonic force. Vicious, soul-disheartening weather, without a ray of sunshine to give token of coming better days. The coldest winter, the heaviest snowfall, and the most backward spring experienced in years are the atmospheric conditions that the officials have had to contend with ; evil conditions that could not be reasoned with or bought off.

And yet the gates were open on time and three-fourths of the exhibits were in place. But had only ten per cent of the exhibitors had their wares in readiness, visitors would have found ample attraction in the buildings and the grounds to have occupied many a day's leisure. For, aside from the exhibits, four hundred separate and distinct buildings have been erected, covering a total space of 6,693,300 square feet, exclusive of state and foreign buildings, and the sum of thirty-three millions of dollars has been expended for the instruction and entertainment of the entire world for the short period of six months.

A list of the actual exhibitors in the Electricity building will be found in the April magazine, the number being somewhat smaller than was expected. That the exhibitors who have generously appropriated funds for a display in keeping with their commercial standing are well satisfied, goes without saying. Of the number who withdrew at the last moment, in several cases under circumstances that left the department in an embarrasing position, several have already regretted their action, and, now that it is too late, realize how great an opportunity for an unexcelled advertising of their products has been thrown away.

To the Standard Electric Company, of Chicago, belongs the well-merited honor of securing the first contract for arc lighting equipment for the power plant in Machinery hall that was



ORNAMENTAL ARC LAMPS IN THE ELECTRICITY BUILDING.

awarded by the World's Columbian Exposition. Moreover, to the Standard Company belongs the credit of having defeated the purpose to require a price that would practically have proved prohibitive, and to have established a rate that enabled the Exposition officials to secure a plant consisting of 4,500 arc lights at a term price nearly one-half less than that called for in the original tenders. That this generous action was highly appreciated by the authorities is clearly indicated in the handsome contract the Standard Company has just received for the exclusive lighting of the power plant in Machinery hall, requiring two 50-light Standard dynamos and 100 Standard arc lamps, and forming one of the best of advertisements. Including these two dynamos, their total working exhibit in the power plant has a capacity of 1,100 arc lights (of 2,000 candle-power). Then there are 200 arc lights and the necessary dynamos in the Electricity building.

The Standard working plant proper, in Machinery hall, consists of twenty Standard dynamos that occupy the section ("S" on the large "Plan of the Power Plant," issued with the February number of this magazine) adjoining the south entrance to Machinery hall, and one of the most prominent in the building. Within this space is the equipment of a complete central station, including line-shafting, and also engines to which Standard dynamos are belted, and a handsomely mounted white marble switchboard arranged for twenty-one 50-light dynamos and twenty-one circuits. The current from this plant will be used in exclusively lighting Agricultural hall, a large portion of the inner basin, and for all-night police service. The two 50-light dynamos to be used in the exclusive lighting of the power plant are also in that section.

The Standard Company's exhibit in the Electricity building occupies a space known as No. 2, Section B, and consists of six Standard arc dynamos equipped with self-oiling and self-centering bearings and other modern appliances, together with 100 Standard lamps of different patterns and for different purposes, with instruments, switchboard, automatic hangers and cut-outs, mast arms, etc., arranged to illustrate the latest and most modern practices in building series arc dynamos and lamps, and a portion of the machinery will be kept in operation to illustrate the successful working of the apparatus, and what is latest and best in series arc lighting work.

It is also worthy of note that during the Dedication Exercises last October, it was the Standard Company that furnished the eleven dynamos and the corresponding complement of lamps that were used in lighting the Manufactures and Liberal Arts building in which the services were held.

DAY'S KERITE EXHIBIT faces the main stairway on the east of the main entrance to the Electricity building, and every visitor ascending the steps is naturally attracted thereto. Within the center of a space 28 by 40 feet in size, inclosed by cables attached to brass railing posts, stands the little parlor, that also serves as a private office, the exterior of which is finished in white and gold, while the interior is rich in artistically carved and highly polished sycamore. A warm rug, luxurious lounge, easy chairs and desk add to the restful appearance of this cosy nook, while tiny electroliers supply the necessary illumination. Placed near the railing are counters on which rest showcases containing samples of kerite insulated wires of all sizes and for every conceivable use, and specimens of pure Para rubber in the raw state, of crude kerite and of insulating compounds. There are also specimens of historic value and letters from users of kerite in the early days of the industry. Then there are fifty natural ash reels on which are wound the various forms of aërial and submarine, armored and lead incased, plain and braided kerite wires and cables made for telephone, telegraph, electric light and power and other circuits. And panneled on the sides of the cottage beneath the golden letters that form the word "Kerite," are silvered brackets supporting samples of special orders of kerite insulated cables. Mr. W. R. Brixey planned and installed the entire exhibit and then placed it in charge of the western agents of kerite, Messrs. Cushing and Morse.

NEARLY adjoining the Kerite display is the exhibit of the Reliance Gauge Company, of Cleveland, that will not only prove attractive by reason of the mirror-like and high mechanical finish on the various articles exhibited, but because it is the most extensive showing of auxiliary appliances in the Electricity building. Every central station manager, and, in fact, every engineer and user of steam is naturally interested in a perfected device for causing the water in steam boilers to be carried uniformly at the proper level, for it means economy in fuel and in the cost of

repairs, to say nothing of the prevention of accidents, and President A. J. Wright, who designed this display, will be present to explain the merits and the mechanical simplicity of the Reliance safety water column, that is so highly indorsed for automatically giving due and unmistakable notice that the water is running low in the boilers.

Included in this exhibit are safety water columns ranging in capacity from six inches variation to a variation of sixty inches between the high and low water alarms. Some are nickel plated, others are of polished brass, and others have a japan finish. Then there are four sectional models of aluminum, showing the construction of the various columns displayed. Another meritorious device that will attract the attention of the observant engineer is the Reliance solderless floats, made without the application of heat in three overlapping parts that are pressed and spun together, thus enabling the metal to retain all resiliency gained by working it with steel tools.

It is worthy of note that the walls of the booth are formed of heavy hanging draperies of olive plush, while on the floor is a heavy blue, olive and black wilton. Then there are easy chairs and a desk from which visitors can indite a note to distant friends, and when Mr. Wright is absent, Mr. George B. Clark, of good New England fame, will play the part of host.

GENERAL WORLD'S FAIR NOTES.

THE circuit-closing device by means of which Mr. Cleveland set the machinery in motion consisted of a telegraph key of usual size, but made of gold and of ivory, mounted on a pyramidal base twelve inches high and formed of three steps covered with blue and with orange plush, the latter the national color of Spain, the blue the American's favorite, while on the lower step were the golden figures, "1492–1893." Connected to this key was the mammoth ajax dry battery tendered by the Ansonia Electric Company, thirty inches high, twelve inches in diameter, and giving six volts and seven ampères; and from key and battery a circuit extended to an electro-magnet controlling a valve on the steam pipe of the big Corliss engine, to a magnet withdrawing a miniature cylinder from a miniature steam chest admitting steam to the great vertical pump supplying the MacMonnies fountain, to electric bells that signalled for the steam chimes, and for the unveiling of the golden statue of the Republic.

FIFTY electric launches, each 35 feet long, 6 feet 6 inches beam, and drawing, when loaded, about 26 inches, are in service in the lagoons. A four horse-power motor directly connected to the propeller shaft drives an 18-inch screw, the regulating switch and wheel being placed forward, while the necessary current is supplied from seventy-eight storage cells placed beneath the seats. As thirty passengers can ride comfortably in each launch, 1,400 to 1,500 visitors can be accommodated at one time, and, as the launches are strongly constructed of oak, with a double planking of cedar and an interior finish of mahogany, with hair-stuffed leather cushions and ample orange and red-striped awning protection, the utmost comfort and safety is assured. The captain, who also presides over the helm, wears a double-breasted coat of blue, with gold buttons, three rows of gilt lace on his sleeves and a gold-lettered cap. From the stern of each launch will fly the United States navy ensign, and from the bow the Columbian maritime flag, having an anchor of yellow surrounded by a wreath of the same color. It is intended that each launch will start from the

landing near the main entrance of Agricultural hall under a minute headway, and, stopping at the various landings, pass to the north pond, and then return via the Woman's and the Transportation buildings to the starting point, moving at the rate of four miles an hour and making the round trip in about fifty-two minutes. In addition to these fifty launches, there are four electric launches somewhat larger that are provided for the use of the exposition officials and their guests.

THE TELEGRAPH OFFICES.—The telegraphic facilities at the World's Fair will be in keeping with the magnitude of the Exposition, the Western Union Company operating forty wires and the Postal Telegraph Company thirty. The main offices of both companies will be located in the Administration building, with branch offices in the principal buildings, the section of the grounds occupied by the State buildings and in the Midway Plaisance.

The main offices are finished in polished oak, with desk room for seventy-two operators, and everything arranged in readiness for the daily transmission of the special press reports, the sending of which is facilitated by having direct connections with several of the larger cities, and the Postal Company intend receiving all incoming messages on the typewriter, thus affording an interesting and instructive exhibit to many.

The Western Union Company will also furnish the time to 300 clocks connected in circuit with the master or governing clock that is located in the Manufactures building and governed from the Washington observatory. Thus every official clock will tick in unison and the correct time of day may be obtained from any one of 300 points, a feature of importance to thousands of visitors.

Exactly at the noon of each day in Washington, an electric circuit in the new observatory will close, and the hands of 70,000 clocks over the country will point to the correct hour. This 12 o'clock signal from Washington indicates 11 o'clock in Chicago, 10 A.M. in Denver and 9 A.M. in San Francisco, and three minutes before noon each day every operator clears his circuits and over 350,000 miles of wire flashes in a second of time the signal that the sun has passed the seventy-fifth meridian. This signal will be made apparent to all by the falling of a five-foot time ball made of canvas stretched over a steel frame. Each morning this ball will be placed in position and electrically connected so that the releasing

of an armature by the breaking of a circuit at Washington will cause it to fall. It is worthy of note that this time service forms an important source of revenue to the Western Union Company, bringing in about $1,000,000 annually. The exhibits of the telegraph companies will be found near the center of the east gallery of the Electricity building.

RULES GOVERNING THE USE OF VEHICLES WITHIN THE EXPOSITION GROUNDS.—Director-General Davis issued the following general order to chiefs of departments :

I have the honor to call your attention to the following regulations governing the handling of supplies, renewals, etc., of which you are directed to notify exhibitors and others having business with your departments who may require this information :

1. No wagon or vehicle of any kind propelled by animal or other power will be allowed about the grounds during the hours the Exposition is open to the public save emergency vehicles, such as fire apparatus and police or hospital patrol wagons, and wagons or carts propelled by man power. This, however, shall not be taken to prohibit the unrestricted use of the official conveyances of the council of administration, director-general, director of works, and such others as may from time to time be expressly authorized and permitted under the specific orders of the council of administration.

2. All supplies arriving at the Exposition grounds, either by rail, vessel or team, must be delivered to the designated warehouses, and there stored until after the hour of closing the Exposition, when the work of delivering such supplies, etc., will begin by and under the direction of the transportation department. The charge for this service will be at the rate of 6 cents per 100 pounds, with 25 cents minimum, with no charge for storage unless supplies remain on hand longer than five days. If held in storehouse more than five days storage rates will be the same as specified in circular T. D. 47 of January 4. Orders for the handling and delivery of goods must be filed at the office of the transportation department of the terminal station not later than 5 P.M. of each day for the service to be performed that night.

3. A limited amount of perishable supplies, such as are absolutely needed, will be delivered through the day by carts propelled by man power. The charge for this service will be 12 cents per 100 pounds, under the same regulations as to the use of warehouses as quoted in paragraph 2.

4. All such service must be performed by team and employés that are in the service of the Exposition, excepting that the Associated, American and Adams Express Companies may deliver packages arriving over their lines with their own forces but under the direction of the transportation department at such hours as above designated. The Hyde Park Gas Company may deliver their material and tools for making repairs to their system under these same regulations.

5. Payments for this service must be made in advance by means of tickets secured from the department of collections.

6. Any complaints regarding the service must be entered at the transportation department office at the terminal station.

SIGNS AND CIRCULARS.—"Rule 16. Exhibitor's business cards and brief descriptive circulars only may be placed within such exhibitor's space for distribution. The right is reserved by the director-general to restrict or discontinue this privilege whenever it is carried to excess or becomes an annoyance to visitors."

The above will be so construed as to give the largest liberty to exhibitors consistent with the interest of the public and the Exposition management.

It is not intended to confine advertising matter to any particular form or to unduly limit its distribution; but exhibitors will be required to confine their descriptive matter strictly to their own business establishments and products of their own manufacture.

The general design, form and style of printed matter for advertising purposes will be left to the exhibitors to determine, subject to the approval of the chiefs of departments.

Attendants will not be permitted to importune visitors to accept advertising matter.

When it is found that any particular advertising matter is thrown away by the recipients, littering the floors and the grounds, the distribution of the same will be prohibited.

Pamphlets and circulars descriptive of the resources and products of states and foreign countries may be distributed gratuitously from the spaces where the collective exhibits illustrating those resources and products are installed, but no advertising matter will be included in such publications.

The dimensions and character of signs must be submitted to and approved by the chiefs of departments before they are placed on exhibits.

ENGINEERING HEADQUARTERS.—The reception rooms and office of the general and executive committees of the Associated Engineering Societies of the United States and Canada and of the general committee of the World's Congress Auxiliary on the International Engineering Congress, will be at 10 Van Buren street, Chicago, Illinois, from May 1 until the close of the Exposition. All communications after May 1 should be addressed to, or in care of, Mr. Max E. Schmidt, secretary. Visiting engineers may have their mail thus addressed. The committee rooms of the Associated Engineering Societies at the Exposition will be situated in the southwest corner of the gallery of the Mines and Mining building, where the secretary or some of the staff will be

present during the Exposition to meet visiting engineers. Mr. E. L. Corthell is chairman of the executive committee. His present headquarters are at room 902, The Temple, Chicago.

THIRTY-THREE MILLIONS EXPENDED.

Following is a statement of moneys raised for purposes of the Exposition, exclusive of cost and value of exhibits:

Appropriated by foreign governments, according to the most recent compilation of the department of foreign affairs made from official data	$5,675,298.00
The compilation made by the department of publicity and promotion from all sources adds to this amount	896,231.00
Total	$6,571,529.00
Contributions by states of the Union	6,020,850.00
Original appropriation by United States government	1,500,000.00
Appropriation by government of five million souvenir coins	2,500,000.00
Appropriation by government for bronze medals and diplomas	103,000.00
Appropriation for government board, 1892	408,250.00
Appropriation for government board, 1893	150,750.00
Appropriation for National Commission, 1891	95,500.00
Appropriation for National Commission, 1892	230,000.00
Appropriation for National Commission, 1893	211,375.00
Receipts from stockholders	5,553,760.80
City of Chicago	5,000,000.00
Six per cent debenture bonds, due January 1, 1894	4,094,500.00
Gate receipts to April 1	234,853.00
Interest	88,963.00
Miscellaneous receipts	295,504.75
Grand total	$33,248,930.55

THE EDITOR'S BRIEF REVIEW.

THE "Incandescent Lamp Situation" continues to be a favorite heading for numerous screeds more or less interesting, and the leading topic among users of dynamo electric machinery not made by the "Combine," who must have given vent to a hearty sigh of relief on receipt of the welcome news that was flashed over the wires from St. Louis on the announcement of Judge Hallett's decision. And the dealers, too, had good cause for rejoicing, for a valuable source of income, limited only by their ability to hustle for orders, was entirely cut off by the injunctions secured by the General Electric Company.

That Judge Hallett's decision was as great a surprise to both users and dealers as it must have been to the General Electric Company is obvious. Naturally the news of the decision was followed by many telegrams and letters to the Columbia Company, containing not only orders but congratulations and words of praise for the pluck and persistency displayed by Mr. Rhotehamel in leaving no stone unturned while securing the testimony that satisfied the court that the Columbia Company was not trespassing on the rights of others; a courage born of convictions so clearly stated as to have won, it is said, the admiration of so astute a student of men as Mr. C. A. Coffin. And as Mr. Coffin has a special fondness for successful men, it is fair to assume that he has already made a tender for Mr. Rhotehamel's services.

Mr. Rhotehamel was freely criticized in securing the legal talent that represented his side of the case so successfully, but the wisdom displayed is clearly exemplified, not only in the outcome, but also in the concise, graphic statements employed by Mr. Kenyon in so clearly picturing out the facts before the court—condensed, convicting facts that won the case and added materially to the fame of the advocate.

WHEN the General Electric Company's annual report appeared in the *Electrical Engineer*—a clean "scoop," by the way, and well illustrating Mr. Martin's ability to "get there"—

it was seized upon as an excellent text on which to hang further abuse of this great organization that has still another rod in pickle for the erring. Just how serviceable these attacks prove in illustrating the advantages enjoyed by the General over its would-be competitors, and in advertising the magnitude of its operations to the world, is not clearly apparent. They certainly indicate in how questionable a position some of the companies must necessarily stand if the statements regarding "the trust" are at all correct. Are these attacks not doing more harm than good to the electrical industry as a whole? Is not one paragraph bristling with convincing facts worth columns of glittering generalities from men who have their own axe to grind?

THE CANDLE-POWER OF ARC LAMPS.—The representatives of various electrical interests in Chicago have addressed a communication to Prof. Elisha Gray, chairman of the electrical congress committee, inviting attention to the confusion existing in the proper designation of arc lamps, and suggesting the following definition for discussion, in the belief that it will most easily enable any electrician to determine whether the terms of the contract relating to candle-power were fulfilled: "The term 2,000 c.-p. is to mean an arc produced by 10 ampères and 45 volts potential difference between the carbons, or a 450-watt arc. The candle-power of arcs produced by currents of more or less ampères, or more or fewer volts difference of potential, to be rated proportionally."

THE *Colorado Magazine* is to be congratulated on securing from Lieut. Irving Hale the thoughtful article appearing in its May number under the title of "Influence of Electricity on Colorado's Progress," and which is a practical answer to the self-propounded question, "What application of electricity will actually increase our prosperity, and exert an active, healthful influence on our development?" Referring to the rapid utilization of electricity by the citizens of Colorado, Mr. Hale mentions that no town having a thousand inhabitants is without its electric lighting plant, every town of three thousand population has its telephone system, while the successful electric railway systems are noted far and wide. Commenting on the stereotyped statement that the mountain water-powers are "inexhaustible," he states that "the

largest streams have less than one-tenth the water from October to March that they have in late spring and early summer, while many of the smaller streams, which are raging torrents in May and June, are practically dry during fall and winter," that often in districts where coal is the most expensive there is no water-power available, and, again, the best water-power is often located where power is not desired. Comparing the larger first cost of a water-power plant required for the same purposes over the initial outlay for a steam plant, he states that while the first cost may vary between $150 and $300 per horse-power delivered, or from three to six times the cost of a steam plant to do the same work, this extra cost will be returned within twenty-four months, and possibly within twelve months, depending on the cost of fuel; that is, if coal costs $5 per ton, the saving effected would pay forty to fifty per cent per annum on the capital invested; but if it was possible to obtain coal for $1.50 per ton, the saving would not pay over ten to fifteen per cent on the investment. The feasibility of the transmission of power to Denver over a distance from fifteen to twenty miles is doubtful from a financial standpoint, under present conditions, as coal may now be obtained in Denver at less than $2 per ton. The electric plant in the Virginius Mine is referred to as having effected a saving under the most adverse conditions that is simply remarkable. Previous to the installation of this plant the cost of the coal consumed amounted to nearly $40,000 per annum, and the forcible statement is made that, at the present price of silver, without this electric plant it would have been impossible to have profitably operated the mine. Mr. Hale claims that Colorado is the richest mineral state in the Union, and that mining is the characteristic industry, and in the development of mining electricity is certain to play an important part. Reference is also made to the application of electricity for operating the pumps connected with the irrigating systems used in distributing water over the wide fertile areas in the lowlands, and of raising water from wells or sunken reservoirs in the sections of the state where the sandy soil rapidly absorbs the water that goes to swell the volume of the underground streams.

A SYNOPTICAL INDEX OF CURRENT ELECTRICAL LITERATURE.

(0000 Articles Indexed.)

ACCUMULATORS.

(See Batteries, Storage.)

ALTERNATING CURRENT APPARATUS.

(See Dynamo Electric Machinery, Electro-Physics and Power Transmission.)

"The 'Hunting' of Parallel Alternators." By James Swinburne. (Discussing the brief statement of H. E. Harrison respecting the peculiar behavior of an alternator of the Siemens type that did not run uniformly, and stating that it is "perhaps the most important discovery made in alternating current work during the last few years." 1,200 words.) London *Industries*, March 31.

"A Hysteresis Theory of Brown's Alternating Current Motor." By J. A. Kingdon. (A clear explanation that "may be termed, 'the hysteresis theory of alternate current repulsions' as distinguished from the self-induction theory," and which, if correct, may cause hysteresis to be considered valuable instead of wasteful. 800 words, 3 illustrations.) London *Electrician*, March 24. See also letter from E. C. Rimington. London *Electrician*, April 7.

"The Brown Single-Phase Alternating Current Motor." (Further correspondence from C. E. L. Brown, in answer to open letters from Elihu Thomson, M. M. Hutin and Le Blanc, and others. 1,000 words.) London *Electrician*, March 31. Reply from Elihu Thomson. 700 words. *Electrical World*, April 29.

"A New Déri Alternate-Current Motor." (Abstract from the *Zeitschrift für Electrotechnik*, March 1. 1,200 words and 5 illustrations. May be regarded as a transformer with two primary currents, the exciter currents in the fields and the working current in the armature; the latter current is opposed by the current induced in the armature by the fields.) London *Electrician*, March 31.

"Non-Synchronous Single-Phase Alternating Motors." By Herbert A. Wagner. (Detailing experiments made some six months ago on a current of 130 periods. 350 words.) *Electrical Engineer*, April 5.

"Non-Synchronous Motors for Ordinary Alternating Currents." By E. Arnold. (Detailing the obstacles surmounted in perfecting a practical non-synchronous motor. See *Electrical Engineer*, March 22. 2,200 words, 3 diagrams, table and illustration.) *Electrical World*, April 8.

"The Calculation of Alternating Current Motors — II." By E. Arnold. (Part I, Jan. 21. Part II, Non-Synchronous Motors. 1,200 words, 2 diagrams.) *Electrical World*, April 8.

"Stanley-Kelly Quarter-Phase Motor." (Description of motors and of factory of Stanley Electric Company. 2,500 words, 12 illustrations.) *Electrical Review*, April 29.

"Concentric Cable Phenomena in Alternate Current Working." By L. Neustadt. (Details of destruction of insulation on concentric cables when a section of the cable was switched in or out, and showing that the inner conductor must never remain coupled on alone. 2,000 words, 4 diagrams.) London *Electrician*, March 10.

"Theory of the Transformer." By F. Bedell and A. C. Crehore. (Part I, March 25.) (Part II. Mutual energy of any two circuits; coefficient of mutual induction; total energy of two similar superimposed circuits; energy of a single circuit; total energy of any two circuits; values of the coefficient of self and mutual induction. 2,000 words.) *Electrical World*, April 8.

"Frequency in Transformers." (Comment on useless calculations regarding transformers and frequencies. 450 words.) London *Industries*, April 7.

"Alternating Currents and Rotary Fields." By Alexander Russell. ("Suggestions for working electricians in picturing to the mind the instantaneous values of an alternating current." 2,500 words, including formulæ, and 5 diagrams.) London *Electrician*, April 7.

"On the Rotary Magnetic Field and Multiphase Alternating Current Distribution." By Ludwig Gutmann. (A review of the principal workers and their devices. 2,600 words.) *Electrical World*, April 15.

BATTERIES, PRIMARY.

"Comparative Tests of Hellesen and E. C. C. Dry Battery Cells." By Professor Jamieson. (A paper read before the Philosophical Society, Glasgow, March 22. 14 curves and diagrams. 7,500 words, including tables.) London *Electrical Review*, March 31. Criticism by H. Lewis Jones, giving comparative results of personal tests. 600 words. London *Electrical Review*, April 14.

"Some Principles that must be observed in order to make a Good Closed-Circuit Battery, and a New Portable Dry Cell described in which these Principles are Applied." By E. F. Northrup. (A paper read before the Franklin Institute.) *Journal of the Franklin Institute* for March. Review and comment by J. T. Sprague. 1,600 words, 2 illustrations. *London Electrician*, April 14.

"The Maximum Electric Current." (Communication from Prof. W. J. Humphreys explaining how "the maximum electric current obtainable from a given number of cells in a given circuit is got when the cells are so arranged that the internal resistance of the battery is as nearly as possible equal to the external resistance of the circuit." 600 words.) *Scientific American*, April 1.